THE INFLUENCE OF CULTURAL PRACTICES AND SEEDED SPECIES ON OVERLAND FLOW AND SEDIMENT PRODUCTION FROM THE BIG SAGE COVER TYPE IN EAST GATE BASIN

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ABSTRACT

Infiltration experiments were used to analyze runoff and erosion losses on marginal big sagebrush (*Artemisia tridentata*) sites in central Nevada. Range cultural practices were applied in 1965 in an unsuccessful attempt to establish perennial grasses. The treatments were: control; plow and drill; plow and deep furrow drill; spray and drill; spray and deep furrow drill; and, rip and drill. In 1966 and 1968 an F-type infiltrometer was used to apply 1.85 inches of water, in 30 minutes, to 55-square-foot runoff plots. These tests were conducted at two sites, under both dry and wet conditions.

The soils at one site (the lower site) are members of a coarse-loamy, mixed mesic family of Typic Camborthids. Ground slope is four percent. This site had 24 percent live shrub cover and no understory. Three years after treatment, the treated plots were essentially bare.

Soils at the upper site belong to a very fine, mixed, frigid family of Xerollic Durargids. Ground slope is 15 percent. This site had 10 percent live shrub cover and 10 percent annual grass cover. Three years after treatment, both the treated and control plots had been invaded by cheatgrass (*Bromus tectorum*), increasing the average annual grass cover to 20 to 45 percent.

In general, the results indicate that unsuccessful conversions on marginal sites will increase sediment production and decrease infiltration. This problem will be more severe when plowing and deep furrow drilling is used as opposed to ripping or spraying and drilling.

Sediment production was most highly correlated with runoff, ground cover, and soil texture. Infiltration at the lower site was most

highly correlated with soil texture. At the upper site, infiltration was most highly correlated with bare ground.

Regression analyses were used to develop infiltration and sediment production prediction equations. The infiltration prediction equations had standard errors of 0.5 inches per hour or less. Multiple regression sediment prediction equations were developed with R^2 values of 0.42 or higher.

More specifically, the dry condition tests indicate the following. Control plots at the lower site yielded approximately 1.0 ton per acre of sediment. Three years after treatment, at the lower site, the sprayed and drilled plots produced slightly less sediment than the control plots. The ripped and drilled plots, and the sprayed and contour furrowed plots produced slightly more sediment. When compared with the control plots, the plowed and drilled plots yielded about 2.5 times as much sediment and the plowed and contour furrowed plots yielded about 3.5 times as much sediment.

Three years after treatment, at the upper site, average sediment production from the control and treated plots was 0.5 tons per acre or less. The low sediment values at this site are attributed to the protection provided by the annual grass ground cover.

Infiltration on control plots at the lower site decreased from an initial rate of about 3.5 inches per hour to about 2.5 inches per hour after 30 minutes. In 1966, the upper site control plot infiltration rate decreased from an initial value of about 3.0 inches per hour to 1.5 inches per hour after 30 minutes.

Three years after treatment, an increase in annual grass cover at the upper site caused the control plot initial rate to increase from 3.0 to 3.5 inches per hour and increased the 30-minute infiltration rate from 1.5 to 3.0 inches per hour. Three years after treatment, at the upper site, treated and control plot differences had been masked by the cheat grass invasion. At the lower site, plowed plots had slightly lower infiltration rates when compared with control, ripped, and sprayed plots.

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INTRODUCTION

OBJECTIVES:

This study utilized infiltration experiments to gain the following objectives:

1) to evaluate (through analysis of variance techniques) the effectiveness of various range cultural practices in reducing sediment production and overland flow;
2) to analyze (through correlation techniques) the effects of plant cover, soils, and microtopography on infiltration and sediment production; and
3) to attempt (through regression analyses) to develop useful prediction equations for average infiltration rates, water retention, and sediment production.

These studies were conducted in the big sagebrush (*Artemisia tridentata*) cover type of the Eastgate Basin in central Nevada (Figures 1, 2, and 3).

The study was initiated by the Bureau of Land Management and the University of Nevada Agriculture Experiment Station on July 1, 1965. Field work was done by Gerald F. Gifford (currently of Utah State University) through April 1967. Infiltration tests were made in 1966. Results obtained from the study to that time were used by Gifford for a Ph.D. dissertation at Utah State University (Gifford, 1968a). An additional paper on these first year effects was presented at the Third Annual Water Resources Conference (Gifford and Skau, 1967).

The study was continued in time. Additional infiltration tests were made in 1968. This paper reports on first and third year treat-

ment differences and third year treatment effects. Relationships between site characteristics and the results from the 1968 infiltration tests are also presented.

LITERATURE:

Range resource managers have long recognized that high intensity rain storms are a major source of soil erosion and surface runoff in the Intermountain Region. This subject and various other aspects of rangeland hydrology have been reviewed by many authors (Bennett and Chapline, 1928; Chapline, 1929; Forsling, 1931, 1932; U.S. Forest Service, 1940; Lassen et al., 1952; Harper, 1953; Gifford, 1968b). A more recent and detailed review is soon to be published by the American Society for Range Management (Branson, et al., publication in 1972 pending).

In recognizing the effects of high intensity storms range resource managers become concerned with improving the hydrologic function (reducing storm runoff and sediment production) as well as increasing the grazing capacity of range watersheds. A common range management practice is the replacement of xeric shrubs with perennial grasses (Stoddart and Smith, 1955; Pechanec, et al., 1965). This action may require only the eradication of competing woody stems, or, in addition, when native grasses are not sufficiently abundant artificial seeding may be required. Drilling, contour furrowing and other cultural practices are often used for this purpose. When successful these practices greatly increase the grazing capacity of the treated area. Although there is abundant literature on various aspects of rangeland hydrology there has been very little work done on the hydrologic effects of range conversion

Woodward (1943) and Woodward and Craddock (1945) reported on infiltration tests made on undisturbed sagebrush-pinyon-juniper sites in the Sevier Lake Basin in Utah. These tests used an F-type infiltrometer on pre-wet 6-foot by 12-foot plots. These reports indicate that plant cover plays an important role in controlling infiltration on sagebrush sites. The effect was most pronounced on relatively loose soil derived from igneous material. On this site, if the plant cover was 25 percent or more the average initial wet infiltration rate was 4 inches per hour or more. A terminal rate of 3.3 inches per hour was reached after 2 hours. However, if the plant cover was only about 5 percent, the infiltration rate decreased from about 4 inches per hour to a terminal rate of about 1.25 inches per hour in 30 minutes. Average infiltration curves based on plant cover and soil parent material were developed.

The sediment data obtained in the Sevier Lake Basin study plus other studies along the Wasatch Front have been summarized by Rosa and Tigerman (1951). In the Sevier Lake Basin study 108 F-type infiltration tests on pre-wet 6-foot by 12-foot plots produced the following results. Bare sagebrush sites (plant cover 2 percent or less) on sandstone, igneous and alluvial parent material produced 12 times as much sediment as comparable sites with fair cover (about 15 percent plant cover). Sites with poor cover (about five percent plant cover) produced from two to six times as much sediment as the fair cover sites. Comparable sites with good cover (about 40 percent plant cover) produced only one-third the amount of sediment as the fair cover sites. Similar results were obtained from sagebrush sites on alluvial soils along the Wasatch Front.

Tigerman (1952) studied the hydrologic effects of grazing, seeding, and burning sagebrush sites. He concluded that in certain cases plowing and seeding on sagebrush sites reduced infiltration and soil stability. These effects were observed in Wyoming and Utah. One site was seeded two years before the investigation and the other seven years before the investigation. Both sites were judged to have fair to very good crested wheatgrass (*Agropyron* spp.) and/or native grass cover.

Meeuwig (1970 and 1971) reported on infiltration tests made on several range sites in the Intermountain Region. Among the sites he examined was the Diamond Mountain Cattle Allotment on the Ashley National Forest in eastern Utah. Sagebrush in this area had been replaced by introduced grasses. The sandy and sandy loam soils are derived from sandstone. His study showed that the three most important variables controlling sheet erosion in this area are: plant and litter cover, soil organic matter content in the surface inch, and slope gradient.

Branson et al. (pending) summarized a study that he did in Colorado (Branson, 1971). In reporting on the runoff effects of converting sagebrush to grass in Colorado, he indicated that during the first three years following treatment the runoff from plowed and seeded watersheds was lower than from untreated watersheds.

Gifford (1972) reported on infiltration and sediment production rates on a plowed sagebrush site in southern Idaho. He concluded that infiltration rates decreased and sediment production increased on the plowed site.

The above review indicates the importance of plant cover in controlling runoff and sediment production from sagebrush sites. The

hydrologic effects of converting sagebrush to grass are not conclusive. It appears that, in some cases, range conversion practices can reduce infiltration and increase sediment production (Tigerman, 1952: Gifford and Skau, 1967; Gifford, 1968a; and Gifford, 1972). However, Branson (1971) indicated reduced runoff from converted Colorado watersheds and, Pechanec et al. (1965) suggest that sagebrush control is helpful in improving watershed conditions.

STUDY AREA:

The Eastgate Basin (Figure 2) lies approximately 120 miles east of Reno, Nevada (Figure 1) and has an area of approximately 200 square miles (Figure 3). Elevation ranges from about 4,500 feet to 10,000 feet. The main stream channel is normally dry during the summer months except for a short stretch where water surfaces over a rock formation at the watershed outlet. Several streams flow year round from adjacent steep canyons but soon become dry as the flow seeps into the alluvial fans surrounding the valley floor.

The basin lies near the eastern edge of the Sierra Nevada rain shadow. The annual rainfall is approximately eight to nine inches on the valley floor. Sagebrush sites on this valley floor are marginal from the standpoint of plant production. The lands are frail and scars created by disturbance heal slowly. The soil-vegetative units of this site are representative of large areas in the Great Basin.

Periodically this basin suffers severe damage from intense summer thunderstorms. Evidence of this damage is seen in deep gullies, extensive surface rilling, and occasional road and culvert washouts. Intense summer storms are not the only source of erosion. Extensive

surface erosion results from snowmelt and from relatively long duration low intensity winter rainstorms.

Since 1963 this basin has been one of a series of hydrological study areas established and maintained by the Nevada State Office of the Bureau of Land Management. The vegetation and soils of this basin were described by Heinze, Tueller, and Eckert (1963). W. H. Blackburn of the University of Nevada will soon publish a new report on this subject.

Within the *Artemisia tridentata/Bromus tectorum* Community of the basin, two study areas were selected (Figures 2 and 3). These areas are designated as the lower site (elevation 5,500 feet) and the upper site (elevation 6,500 feet) and are described in more detail below. Gifford (1968a) summarized some of the important site characteristics as they existed in August 1965 when the study was initiated (Table 1). The two areas were similar in vegetation composition but not in plant cover, elevation, average slope, and general soil characteristics.

The soils at the lower site are members of a coarse-loamy, mixed, mesic family of Typic Camborthids. The upper site belongs to a very fine, mixed frigid family of Xerollic Durargids. Detailed soil profile descriptions are shown in Appendix A.

In general, the soil at the lower site belongs to hydrologic group B (U.S.D.A., 1971) and has little or no profile development. The texture is generally a sandy loam with some coarser material. Some illuviation has taken place but not enough to form an argillic horizon. Permeability is high with no restrictive horizons within 30- to 40- inches.

Soil at the upper site belongs to hydrologic group D (U.S.D.A., 1971) and has a well developed profile. Illuviation has produced a dense argillic horizon about 7 inches below the surface which in turn is underlain by an indurated duripan with an upper surface at approximately 18 inches.

Table 1.--Summary of study area site characteristics in August 1965[a/]

	Lower Site	Upper Site
Elevation (feet)	5,500	6,500
Slope (percent)	3-4	10-22
Rock cover (percent)	3.0	13.0**
Live shrub canopy coverage (percent)	24.5**	9.5
Litter cover (percent)	19.7	19.0
Organic Matter, 0-1 in. depth (percent)	0.5	0.7**
Organic matter, 1-4 in. depth (percent)	0.4	0.7**
Rock > 2mm, 0-1 in. depth (percent x weight)	19.5	33.5**
Rock > 2mm, 1-4 in. depth (percent x weight)	19.7	27.5**
Bulk density (gms/cc)	1.58**	1.41

a/ Gifford, 1968a

** Significantly larger (probability level 0.01) than value measured at other site.

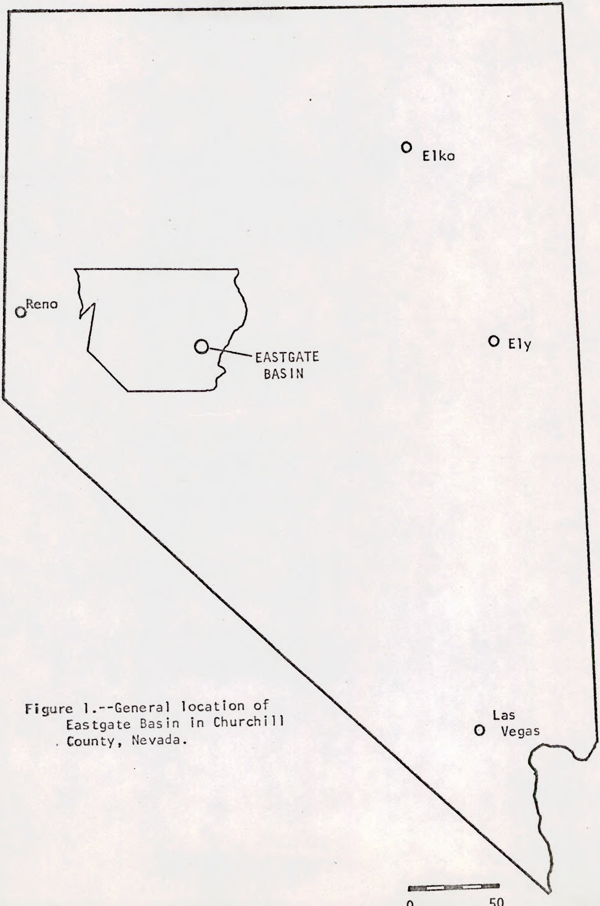

Figure 1.--General location of Eastgate Basin in Churchill County, Nevada.

Figure 2.--General view of Eastgate Basin, looking south east. Note approximate locations of lower and upper study areas (L.S. and U.S. respectively).

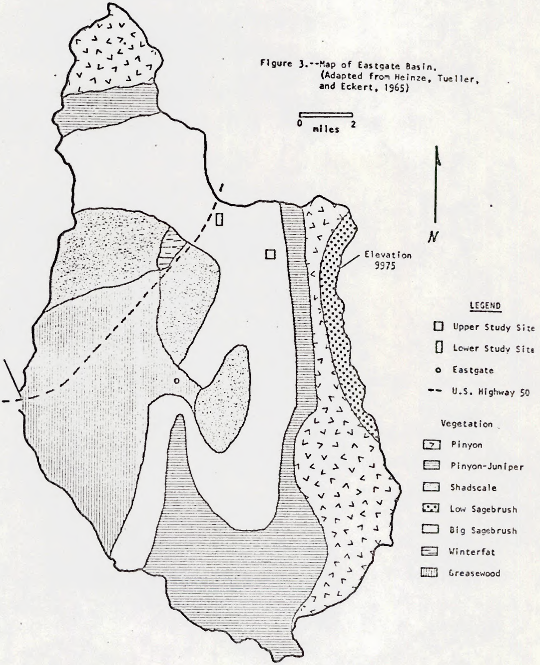

Figure 3.--Map of Eastgate Basin. (Adapted from Heinze, Tueller, and Eckert, 1965)

METHODOLOGY

Each study area was divided into 48 macroplots. Macroplots at the lower site were 100 by 50 feet. Macroplots at the upper site were 50 by 50 feet. Smaller macroplots were utilized at the upper site in an attempt to obtain some degree of homogeneity in slope, aspect, and soil type among the rolling topography.

TREATMENTS:

The treatments were originally established in 1965. They included five cultural practices, two seeded species, and a control for a total of 11 separate treatments. In time, a variety of factors led to a slightly different classification of treatments (Table 2) with four replicates in each classification. Most readers will find the treatments sufficiently described in the following paragraphs. Persons desiring a more detailed description of the development of these treatments are referred to Appendix E.

Two species of grass were seeded (fairway crested wheatgrass, *Agropyron cristatum* and, intermediate wheatgrass, *Agropyron intermedium*).

Ripping was done with a subsoiler to a depth of 8 to 15 inches. The individual rips were spaced at approximately five-foot intervals. Spraying was done with 2,4-D herbicide. Plowing was done with a moldboard plow. Drilling was done with a standard baby rangeland drill. Contour deep furrow drilling was done with a modified baby rangeland drill (Asher, 1971, 1972). The modifications included the removal of two discs, leaving three more widely spaced discs (24-inch spacing instead of 18-inch spacing) and applying increased curvature and more weight to the remaining three discs. The result is deeper, wider, and more widely spaced furrows.

In 1966, one-half of the plots (24 at each site) were used for infiltration tests. Very little of the seeded grass became established; hence, the plots that were not used in the 1966 infiltration tests were redrilled in 1967 in an attempt to establish a successful seeding. *Agropyron desertorum* was the 1967 seeded species.

DESIGN AND INSTALLATION OF RUNOFF PLOTS:

Runoff plots were installed near the lower end of each macroplot. The approximate size of each runoff plot (Figure 4) was 55 square feet. Following construction, the actual plot area varied from 50 to 60 square feet. Gifford (1968a) describes details of the construction and installation of these runoff plots.

INFILTRATION WORK:

In order to compare treatment effects and to evaluate the effects of plant cover, soils and microtopography on runoff and sediment production, a uniform storm is needed. The best way to obtain such a storm in a semi-arid region is to use artificially applied rainfall.

An instrument (hereafter referred to as the infiltrometer) was designed to apply a reasonably uniform amount of artificial rainfall over an entire runoff plot. The infiltrometer (Figure 5) employed 14 vertical F-type nozzles (Dortignac, 1951) and was capable of applying 3.7 inches per hour when the water pressure was maintained at 22 pounds per square inch. A wind frame surrounded the runoff plot and infiltrometer during the tests to provide protection from winds which, if allowed to pass over the infiltrometer, would reduce the uniformity of rain drop application.

During each infiltration test, water was applied at 3.7 inches per hour for 30 minutes. Rainfall frequency data for short duration storms

is extremely limited in central Nevada. However, this investigator and other Nevada resource managers feel that a storm of approximately this magnitude probably hits someplace in Nevada nearly every year. Woodward (1945) indicated that a storm of this magnitude has a return interval of 15 to 20 years in the Sevier Lake Basin, Utah. In the past, other studies utilizing F-type infiltrometers (Rosa and Tigerman, 1951; Meeuwig, 1970, 1971) have used application rates of 1.5 to 5 inches per hour for 30 minutes or longer.

Infiltration tests were conducted in August, 1966 and in August and September, 1968. Tests were made in both a dry and wet condition. A dry run was the initial test made under existing field conditions when the surface soils were nearly in an air-dry condition. The second or wet run was made approximately 24 hours later when the soils were at, or near, field capacity. It is important that the reader recognize that soil moisture content is not the only difference between a dry and wet test. Some differences in micro-relief must be expected as a result of raindrop impact and surface erosion during the dry test. During the dry tests contour furrows were overtopped allowing large rills to develop in interfurrow areas. These differences in plot condition will be reflected in the dry-wet comparisons.

Infiltration was defined at any point in time as the difference between total precipitation and total runoff. Therefore, the term infiltration includes infiltrated water plus water intercepted by plants, ponded on the surface, and in transit to the collection system.

Rates and amounts of runoff and sediment production were determined from runoff samples obtained at various intervals throughout the runoff period. After the artificial rainfall was terminated, runoff

measurements were maintained until all runoff ceased. This provided information on total inches of water retained on the plots.

Sediment collection methodology varied significantly between the 1966 and the 1968 tests. During the 1966 tests small samples of sediment and water were periodically collected from the total runoff obtained since the last sediment sample. This sample was dried, weighed, and expanded to give total periodic suspended sediment production. No attempt was made to clean out the collection systems (gutters and drain hoses) after the tests. Thus, an unknown amount of sediment moved from each plot into the collection system but was not transfered to the collecting point.

During the 1968 tests, large amounts of sediment moved into the collection system. Occasionally, this material had to be swabbed out of the collection system to prevent water from backing up and overtopping the drain system. Swabbing yielded minor surges in runoff drainage and major surges in sediment production during the tests. Thus, no attempt has been made to show sediment production rates during the runoff period. After the runoff period, sediment trapped in the drainage system was collected and recorded. The sediment collected during the runoff period is called suspended sediment and is comparable with the sediment collected in 1966. This amount plus the sediment trapped in the collection system in 1968 is called total sediment production and is not comparable with the sediment collected in 1966.

All of the sediment collected during and after the 1968 tests was retained for drying and weighing.

Table 2.--Treatments resulting from the combined cultural practices of 1965 and 1967 (four replicates in each treatment).

No.	Code[a/]	Treatment Description
1.	RD1	Rip and drill in 1965. Test with infiltrometer in 1966.
2.	PMD1	Plow, contour deep furrow drill in 1965. Test with infiltrometer in 1966.
3.	C1	Control. Test with infiltrometer in 1966.
4.	SMD1	Spray herbicide, contour deep furrow drill in 1965. Test with infiltrometer in 1966.
5.	SD1	Spray herbicide, and drill in 1965. Test with infiltrometer in 1966.
6.	PD1	Plow and drill 1965. Test with infiltrometer in 1966.
7.	RD2	Rip and drill in 1965. Drill in 1967.
8.	SD2	Spray and drill in 1965. Drill in 1967.
9.	PD2	Plow and drill 1965. Drill in 1967.
10.	PMD2	Plow and contour deep furrow drill in 1965. Contour deep furrow drill in 1967.
11.	SMD2	Spray herbicide and contour deep furrow drill in 1965. Contour deep furrow drill in 1967.
12.	C2	Control. Not tested with infiltrometer in 1966.

a/ In future tables and figures a mnemonic code is used to help the reader recall the above treatment descriptions. The codes are as follows: R = rip; D = drill with standard baby rangeland drill; P = plow; MD = drill with modified baby rangeland drill; S = spray; C = control; the number 1 implies plots established in 1965 and tested with the infiltrometer in 1966; the number 2 implies plots established in 1965, not tested with the infiltrometer in 1966, and retreated in 1967.

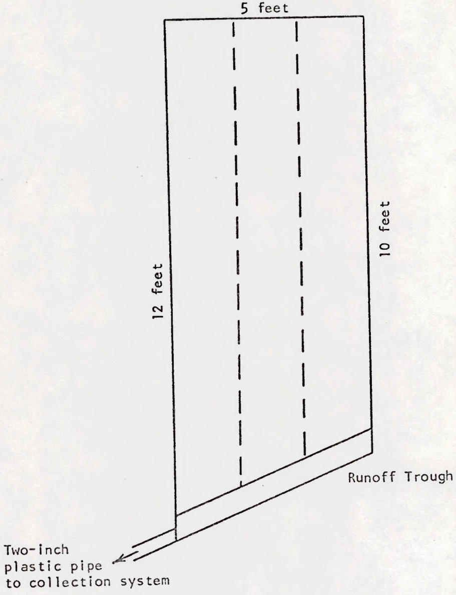

Figure 4.--Plan view of 55-square-foot runoff plot. Dashed lines represent locations of vegetation and micro-relief transects.

Figure 5.--Photo of infiltrometer, runoff plot, and wind frame.
Photo taken at lower site.

RUNOFF PLOT PARAMETERS:

A number of plot parameters were obtained to provide data on the effects of plant cover, soils, and microtopography on infiltration and sediment production. Some of these parameters were used as independent variables (in regression analyses) for predicting infiltration, water retention and sediment production. The parameters are listed in Table 3 and described below.

Canopy Cover and Soil Surface Characteristics

A horizontal 12-foot long point frame with 144 points (Figure 6) was used to record plant cover and soil surface characteristics (X23 through X36).

Two transects were established lengthwise on each runoff plot (Figure 4). The first was located approximately one-third of the way across the plot and the second approximately two-thirds of the way across the plot. Because the plots were not 12 feet long on both sides, the average number of points per plot was about 215.

As each point was dropped a record was kept of the canopy characteristics and of the ground surface characteristics. Since both canopy and ground cover strikes were recorded it was possible to attain more than 100 percent total cover (X35, canopy plus ground cover).

A list of the recorded characteristics (X23 through X36) is shown in Table 3. For the most part the names of variables X23 through X36 are sufficiently descriptive. Two terms for bare ground are utilized. The first (X33) considers rocks greater than 1/4 inch in any dimension as ground cover. The second (X34) considers rocks greater than 1 inch in any dimension as ground cover.

Surface Roughness and Slope of Plot

A surface roughness sampler (Figure 7) was constructed as follows. A 12-foot, 1.5-inch diameter aluminum pipe was drilled to accept 72 1/4-inch round, 3-foot long wooden dowels at 2-inch intervals. Thin welding rods were first tried but found to be unsatisfactory because the small diameter and relatively large weight caused the rods to penetrate much of the finely textured soil. The top three or four inches of each dowel was painted bright red. A black and white one-inch grid on 1/4-inch plywood was bolted upright to the pipe. Adjustable support legs were attached at each end.

The horizontal sampler was placed lengthwise over the plot one-third of the plot width distance from the south side of the plot (Figure 6). The wooden dowels were allowed to slide down so the bottom of each rod rested on the ground surface. The tops of the rods being directly in front of the one-inch grid gave an accurate representation of the ground profile at two-inch intervals. Rather than record individual measurements from the sampler in this position a 35-mm colored slide was made of the plot and sampler. The process was then repeated two-thirds of the distance across the plot (Figure 4).

After the field season each slide was projected on to a large green chalk board. The height of the wooden dowel located at the lower edge of the runoff plot was recorded as zero. The relative height of the remaining dowels were recorded. In this manner, the X and Y coordinates of the tops of the two-inch spaced dowels were obtained.

The data from each transect was then submitted to a simple linear regression forcing the regression line through the origin (the top of the first wooden dowel). The slope of this line represented the slope of the ground (X52).

Using this predicted line as a smooth surface the deviations between the smooth surface and the actual ground surface were obtained at each dowel. The sum of the squares of these deviations was called the roughness factor (X53). Because squaring the deviations gave more weight to the larger deviations a second measure of roughness was also obtained and tested. This value called the absolute roughness factor is the absolute sum of the deviations (X54). The X52, X53, and X54 variables obtained from each of the two transects per plot were averaged to yield representative values for each plot.

Soil Bulk Density

A nuclear surface density and moisture probe (Troxler Model No. 1401) was used to obtain three measures of dry soil bulk density.

The first measure (X41) was obtained using the gamma ray back scatter method. In this method, both the source and the detector are above the ground surface. Gamma rays are emitted and the relative amount of returning radiation is proportional to the soil density. The exact depth of soil affecting the average rate of radiation return is unknown but concentrated in the upper six inches of most soils.

The second and third methods (X42 and X43) are transmission methods and are similar to one another. The gamma ray source was inserted two inches and four inches into the soil respectively, while the detector remained at the soil surface. The relative amount of

radiation transmitted through the soil is inversely proportional to the soil density between the source and the detector.

Soil Profile Rock Content and Texture

Two one-quart samples of soil were collected adjacent to each runoff plot. One sample was obtained from the surface inch and the other from the one to four-inch horizon. The rock proportion greater than 2mm (X37 and X38) was obtained by sieving and weighing air dry samples. Soil texture (X44 through X51) was obtained by the hydrometer method (Day, 1965).

Soil Organic Content

The organic matter content in the surface-inch and in the one to four-inch horizon (X39 and X40) was determined by a modified Walkley and Black dichromate method (Forest Soils Comm. of the Douglas-fir Region, 1953).

Table 3.--List of dependent and independent variables screened in 1968 regression and correlation analyses.

No.	Name Code	Variable Description	Terms used in Description
Y 4	I5	Average infiltration rate after 5 minutes	inches per hour
Y 5	I10	" " " " 10 "	"
Y 6	I15	" " " " 15 "	"
Y 7	I20	" " " " 20 "	"
Y 8	I25	" " " " 25 "	"
Y 9	I30	" " " " 30 "	"
Y10	INR	Inches of water retained on plot after runoff	inches
Y21	SED	Total sediment production	tons per acre
X22	SRO	Inches of runoff	inches
X23	LSC	Live shrub canopy cover	0-100 percent
X24	TSC	Total shrub canopy cover	" " "
X25	AGC	Annual grass canopy cover	" " "
X26	PGC	Perennial grass canopy cover	" " "
X27	GRC	Total grass canopy cover	" " "
X28	TCA	Proportion total canopy cover ((X24 + X27)/100)	0-1
X29	VGC	Live vegetation ground cover	0-100 percent
X30	LIT	Litter	" " "
X31	PAV	Rock "pavement" (1/4 to 1-inch in any dimension)	" " "
X32	ROC	Rock ground cover (> 1-inch in any dimension)	" " "
X33	BG1	Bare ground (may have overstory)	" " "
X34	BG2	Proportion bare ground ((X31 + X33)/100)	0-1
X35	TCO	Total cover (X28 + X36)	0-200 percent
X36	TGC	Total ground cover (X29 + X30 + X31 + X32)	0-100 percent
X37	RP1	Proportion rock > 2mm in surface inch of soil	0-1
X38	RP2	Rock > 2mm in 1 to 4-inch horizon	0-100 percent (weight)
X39	OM1	Soil organic matter in surface inch	" " " "
X40	OM2	Soil organic matter in 1 to 4-inch horizon	" " " "
X41	DBS	Soil surface bulk density by backscatter method	g/cc
X42	BD1	Soil bulk density in 0 to 2-inch horizon	g/cc
X43	BD2	Soil bulk density in 0 to 4-inch horizon	g/cc
X44	SA1	Sand fraction in soil surface inch	0-1
X45	SI1	Silt fraction in soil surface inch	"
X46	CA1	Clay fraction in soil surface inch	"
X47	SC1	Silt plus clay fraction in soil surface inch	"
X48	SA2	Sand fraction in soil 1 to 4-inch horizon	"
X49	SI2	Silt fraction in soil 1 to 4-inch horizon	"
X50	CA2	Clay fraction in soil 1 to 4-inch horizon	"
X51	SC2	Silt plus clay fraction in soil 1 to 4-inch horizon	"
X52	SPE	Slope tangent (percent slope expressed as decimal)	"
X53	RF2	Roughness factor	inches - squared
X54	ARF	Absolute roughness factor	inches

Figure 6.--Photo of vegetation transect point frame. Photo taken at lower site control plot.

Figure 7.--Photo of micro-relief grid. Photo taken in 1968 at upper site spray, drill plot. Note dense stand of cheat grass.

STATISTICAL ANALYSES

A summary of selected dependent variables collected in 1966 and 1968 is tabulated in Appendix B. Analysis of variance techniques were used to test treatment, site, moisture condition and time effects on many of these variables. Some of these variables were used as dependent variables in simple and multiple linear regression equations.

AVERAGE INFILTRATION CURVES:

Average infiltration curves for each treatment, moisture condition and site are shown in Figures 8 through 31. Figures 8 through 19 are separated by treatment. Each figure compares the dry or wet infiltration curves by sites and years. Figures 20 through 31 illustrate, by treatment, the dry and wet 1968 infiltration curves at both sites. Infiltration rates shown on these figures were analyzed by the analysis of variance techniques described below.

ANALYSES OF VARIANCE:

Gifford and Skau (1967 and Gifford 1968a) reported on an analysis of variance to determine the first year influences of treatment, site and moisture condition on several of the 1966 variables for treatments 01 through 06. These analyses are not included in this paper.

The significance of differences represented in each of the following analyses of variance was determined using Duncan's New Multiple Range test (Steel and Torrie, 1960).

A one-way analysis of variance comparing two sites and two years by treatment and moisture condition was conducted for treatments 01 through 06. The values used in these comparisons are the average infiltration rates after 10, 20, and 30-minutes(I10, I20, and I30),

the average inches of water retained on the plots INR), and the average suspended sediment production during the runoff period. The results of these analyses are shown in Tables 4 through 8.

A three-way analysis of variance was conducted to determine the influence of treatment, site, and moisture condition on the average infiltration rates after 10, 20 and 30-minutes, the average inches of water retained on the plot, and the average total sediment produced (SED) for the 1968 infiltration tests. The results of these analyses are shown in Tables 9 through 18.

A series of one-way analyses of variance were used to separate 1968 treatment effects by site and moisture condition on several dependent variables. The tested variables are the average infiltration rates after 10, 20, and 30-minutes, the average inches of water retained on the plot, and the total sediment produced during the runoff period. The results of these analyses are shown in Tables 19 through 28.

A series of one-way analyses of variance were used to analyze the treatment effects by site on several 1968 independent variables. The results of these analyses are tabulated in Appendix C. The tested variables are average percent live shrub canopy (X23), average percent perennial grass canopy (X26), average total grass canopy (X27), average percent total cover (X35), average percent bare ground (X33), soil organic matter in the surface inch (X39), soil bulk density in the surface two-inches (X42), and soil bulk density in the surface four-inches (X43).

REGRESSION AND CORRELATION ANALYSES:

Gifford (1968a) reported on several multiple regression analyses based on data collected at these sites in the summer of 1966. His data are based on 24 plots at each site under two moisture conditions (dry and wet) yielding a total of 96 observations(24 X 2 X 2). An arbitrary value of one (1) for dry plots and two (2) for wet plots was assigned to the independent plot condition variable. The plot condition variable occurred in each of the 1966 regression equations.

A different approach is used below in analyzing the 1968 data. The intent is to provide a separate regression and correlation test for each site and moisture conditon. The tests are identified as: 1968 lower site dry test (LSD); 1968 lower site wet test (LSW); 1968 upper site dry test (USD); and 1968 upper site wet test (USW).

A list of dependent and independent variables initially screened in 1968 tests is shown in Table 3. Actual correlation coefficients and the significance of relationships between selected dependent and independent variables observed during the 1968 tests are shown in Appendix D. Simple linear correlations between the independent variables are also shown in Appendix D.

Simpleand multiple linear regression analyses were calculated using a Fortran IV computer program at the University of Nevada Computer Center. This program (BMD 02R) computes a series of multiple linear regression equations in a forward stepwise manner (Dixon, 1970). Each step adds the independent variable that yields the greatest reduction in the error sum of squares. Additionally, variables are removed from the equation if their F-values become too small.

Several initial regression analyses were used to screen the variables shown in Table 3. The preliminary regression tests were made with several combinations or groups of the data. These combinations were:

1. Both sites and dry and wet conditions combined
2. Both sites, dry conditions
3. Both sites, wet conditions
4. Sites and conditions separated.

Analyses of these preliminary regressions led to the selection of a limited number of independent variables Table 31, page 98) to be used in further refinement of the prediction equations.

Strong differences in physiography, soils, and vegetative cover between sites and in runoff behavior between moisture conditions led to the decision to adopt group four from above and separate the data to provide four equation categories for each dependent variable. The four equation categories represent the following site and moisture combinations:

1. Lower Site Dry (LSD)
2. Lower Site Wet (LSW)
3. Upper Site Dry (USD)
4. Upper Site Wet (USW)

Two regression equations are shown for each dependent variable in each category. The first is the best simple linear regression equation for the variable. The second equation for each variable is the multiple linear equation yielding the lowest standard error of estimate.

The dependent variables selected for regression analyses (Table 31, page 98) were those that the author thought would be most useful for resource managers. They are the average infiltration rates after 10, 20, and 30-minutes, the total amount of water retained on the plots, and the total sediment produced by the runoff.

The common logarithm of the sediment production was used as the sediment dependent variable (LOGSED) because the untransformed sediment data did not follow a normal distribution; that is, most of the observations were less than the mean. When transformed to logarithms, the distribution was more nearly normal (equal numbers of occurrence on either side of the mean). The LOGSED variable was tested twice. The first test used only plot conditions as independent variables. Because total runoff is an important parameter controlling sediment production, a second test was conducted allowing surface runoff (X22) to be included in the regression equations.

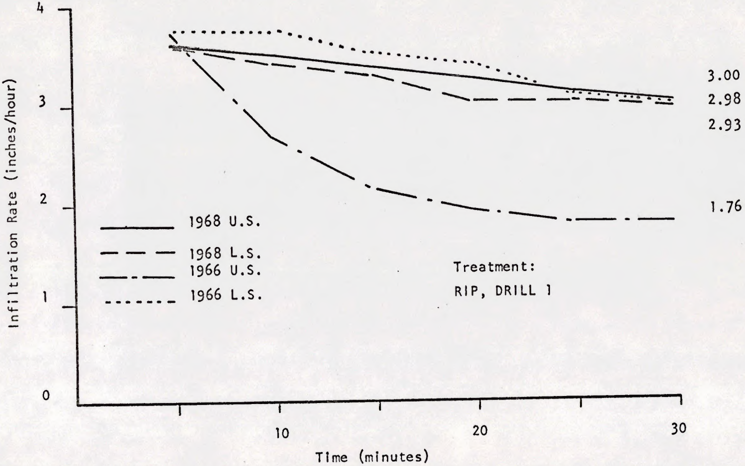

Figure 8.--Treatment No. 01. Average dry 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

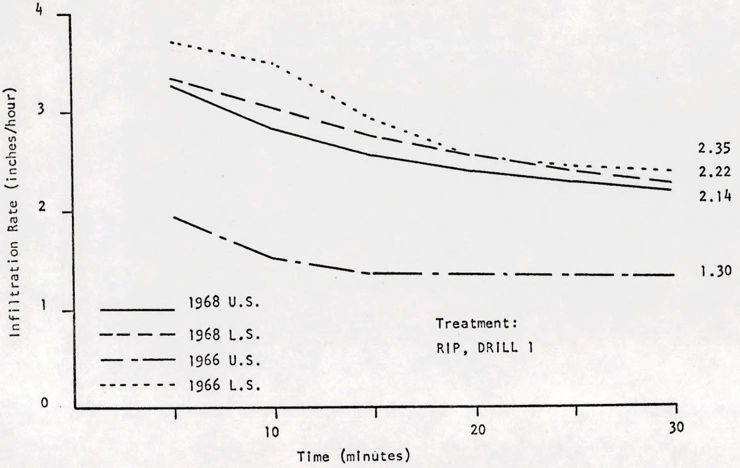

Figure 9.--Treatment No. 01. Average wet 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

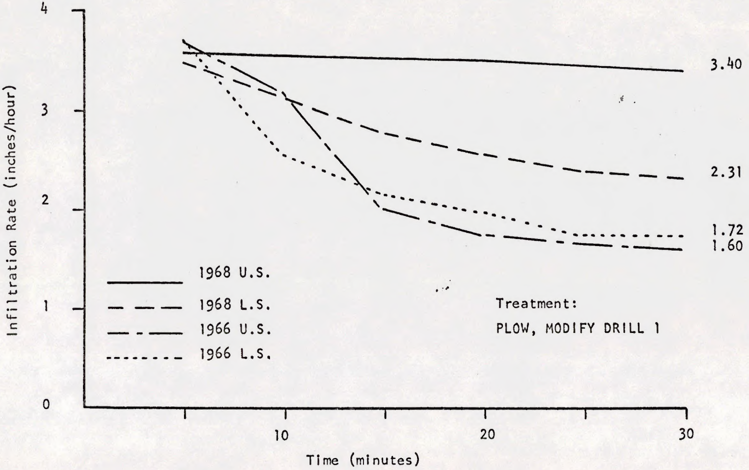

Figure 10.--Treatment No. 02. Average dry 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

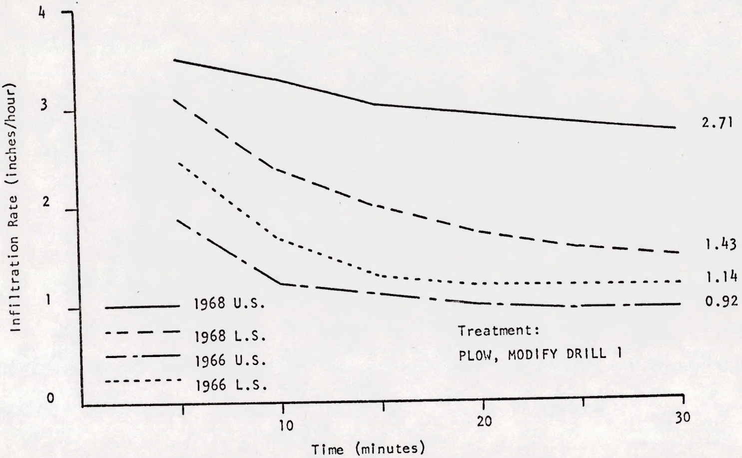

Figure 11.-- Treatment No. 02. Average wet 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

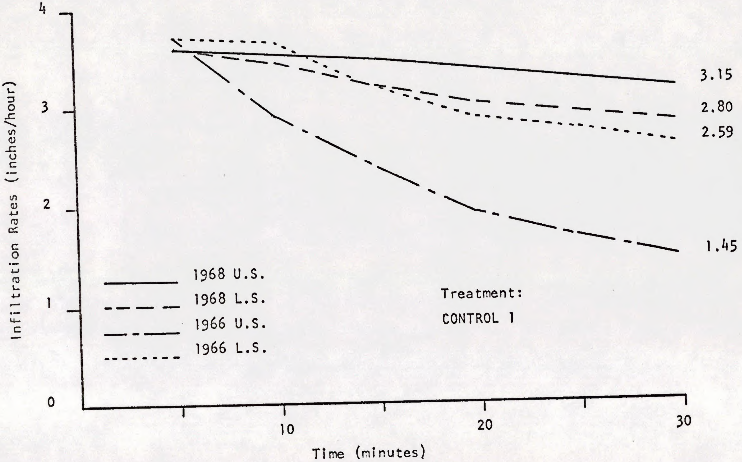

Figure 12.--Treatment No. 03. Average dry 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower site

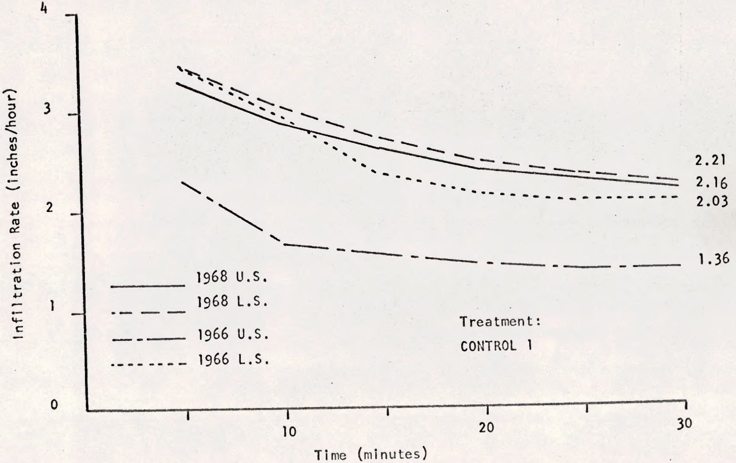

Figure 13.--Treatment No. 03. Average wet 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

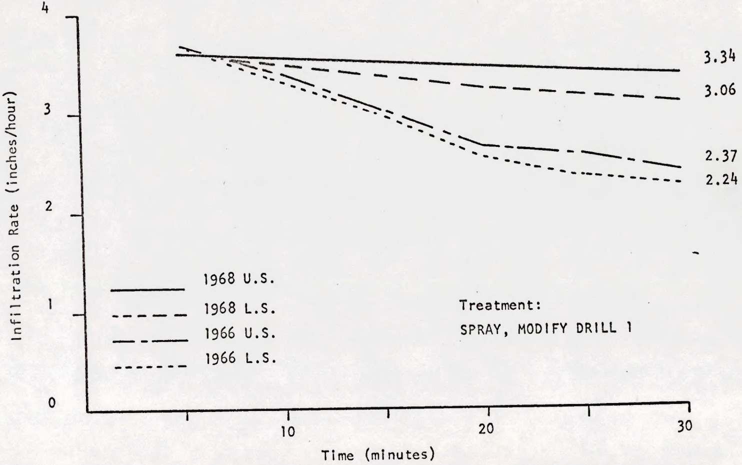

Figure 14.--Treatment No. 04. Average dry 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

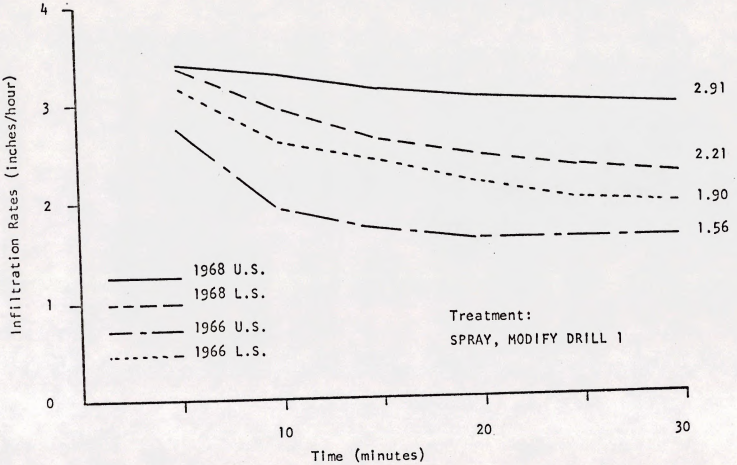

Figure 15.--Treatment No. 04. Average wet 1966 and 1968 infiltration curves.
U.S. implies Upper Site; L.S. implies Lower Site.

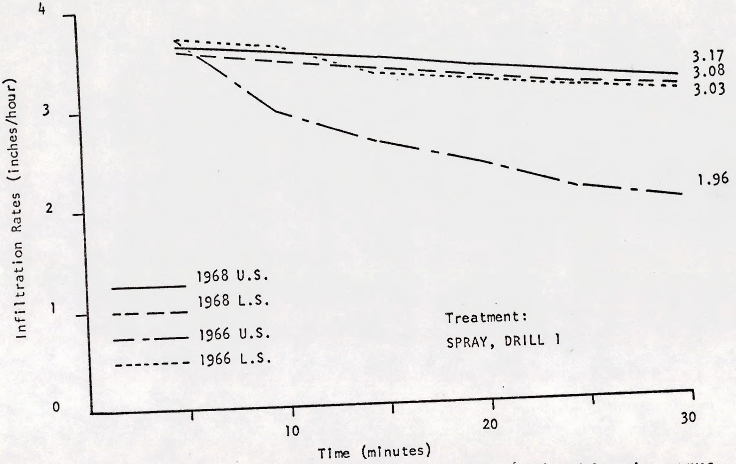

Figure 16.--Treatment No. 05. Average dry 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

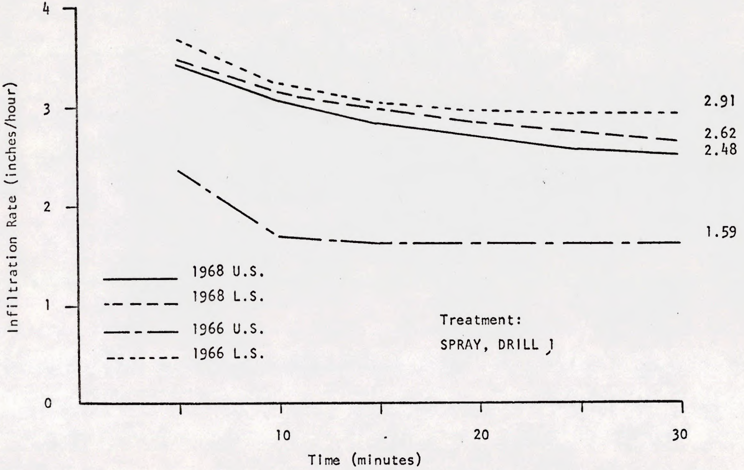

Figure 17.--Treatment No. 05. Average wet 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

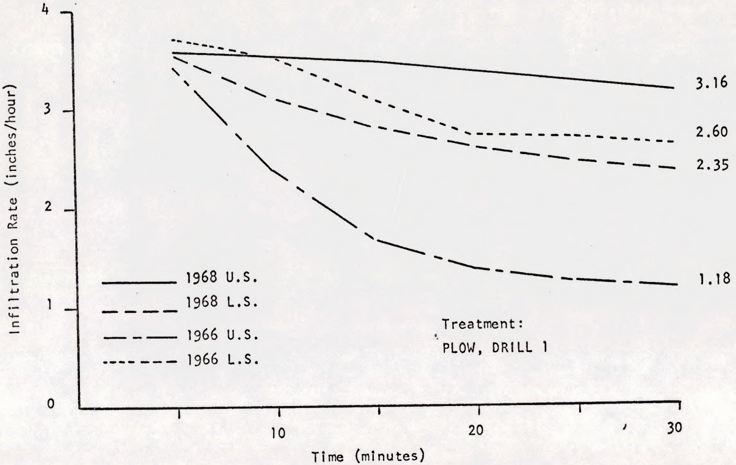

Figure 18.--Treatment No. 06. Average dry 1966 and 1968 infiltration curves. U.S. implies Upper site; L.S. implies Lower Site.

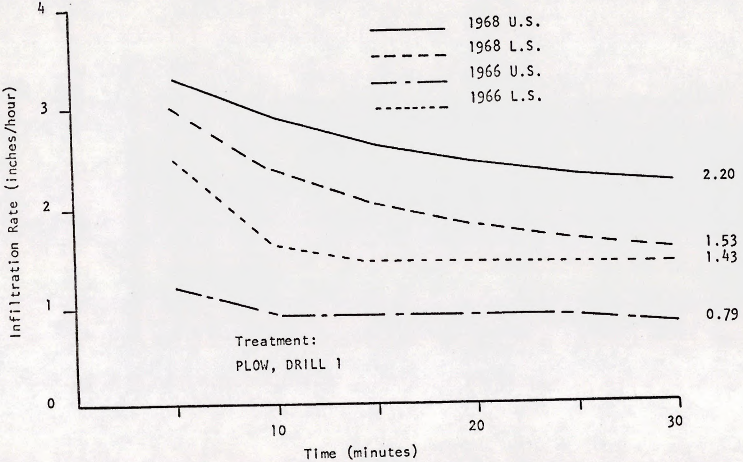

Figure 19.--Treatment No. 06. Average wet 1966 and 1968 infiltration curves. U.S. implies Upper Site; L.S. implies Lower Site.

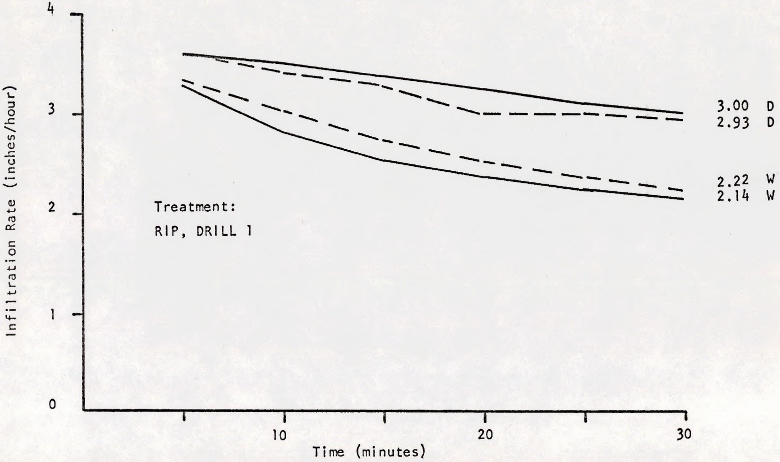

Figure 20-- Treatment No. 01. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed Line represents Lower Site.

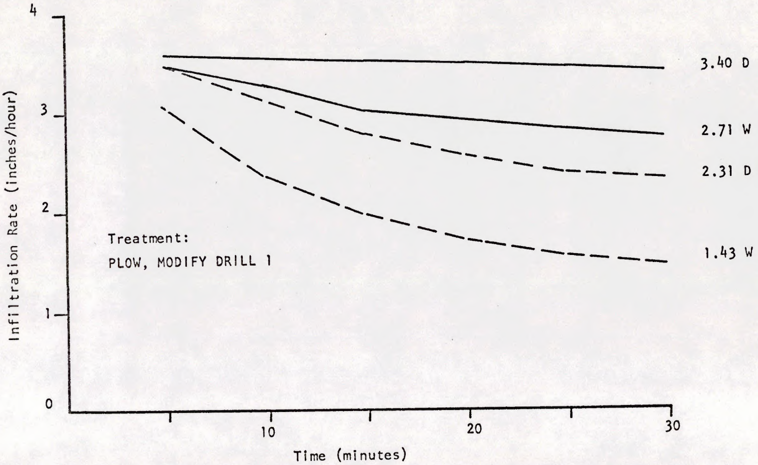

Figure 21.--Treatment No. 02. Average Infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

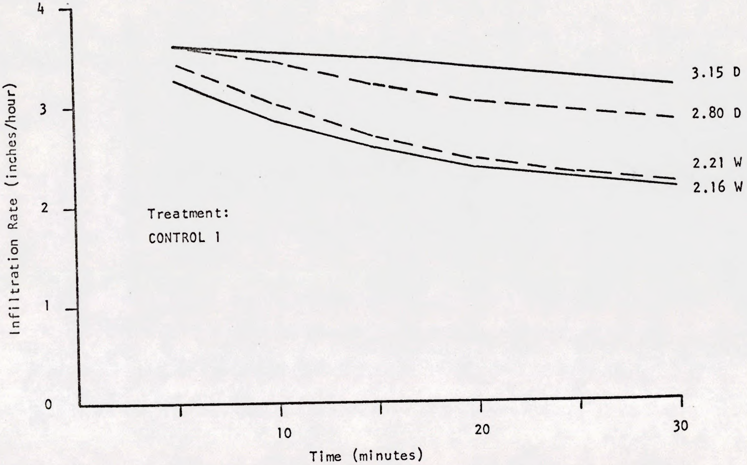

Figure 22.--Treatment No. 03. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

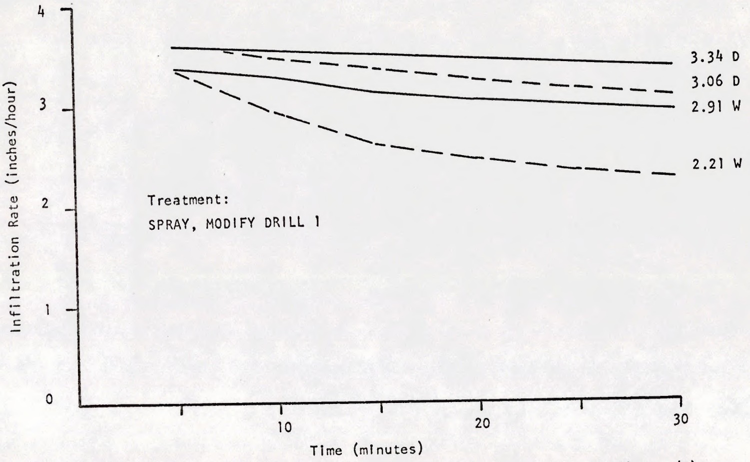

Figure 23.--Treatment No. 04. Average infiltration curves for 1968 Dry (D) and Wet (Wet) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

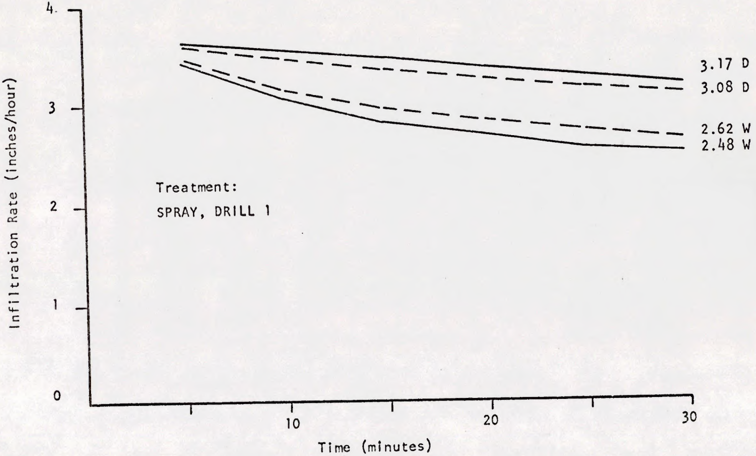

Figure 24.--Treatment No. 05. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

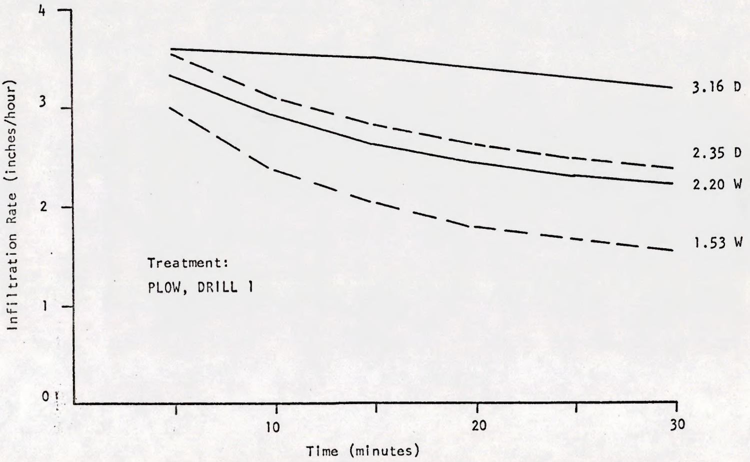

Figure 25.--Treatment No. 06. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

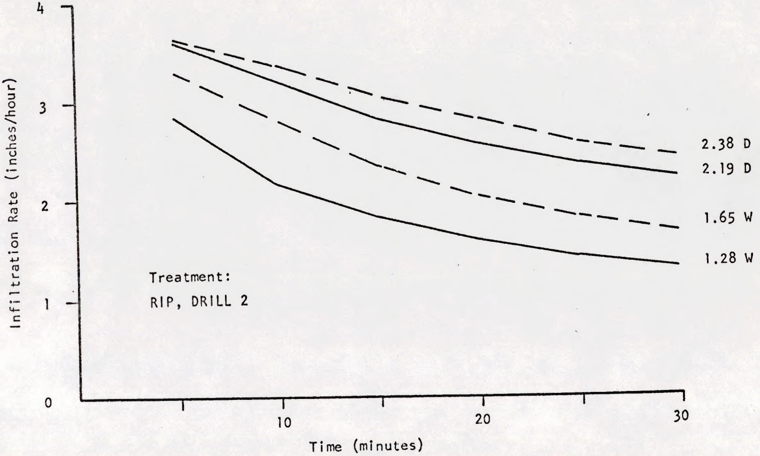

Figure 26.--Treatment No. 07. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

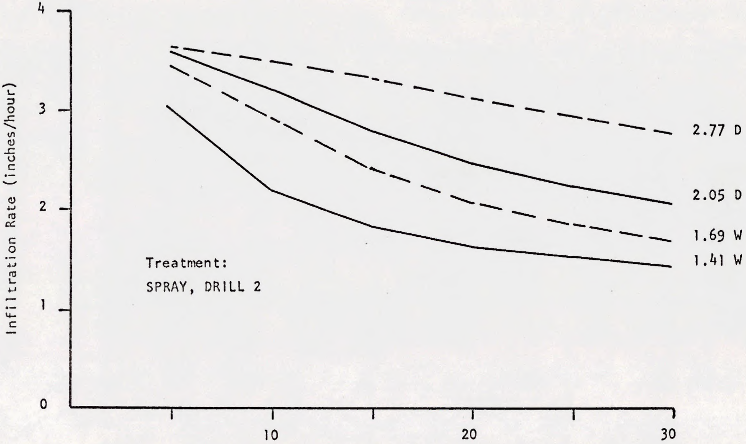

Figure 27.--Treatment No. 08. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

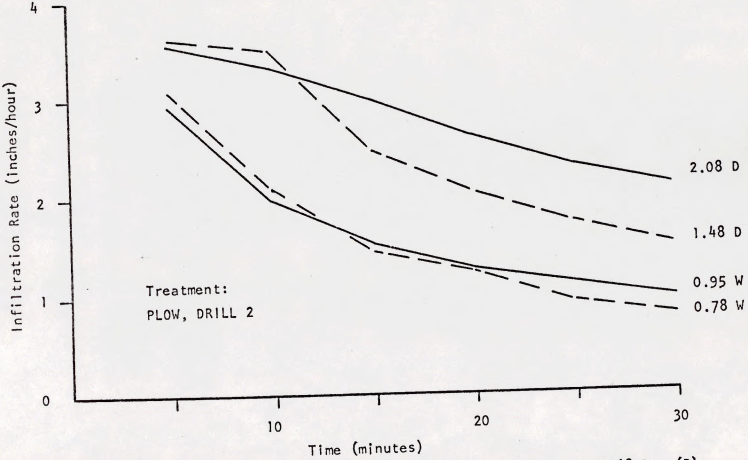

Figure 28.--Treatment No. 09. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

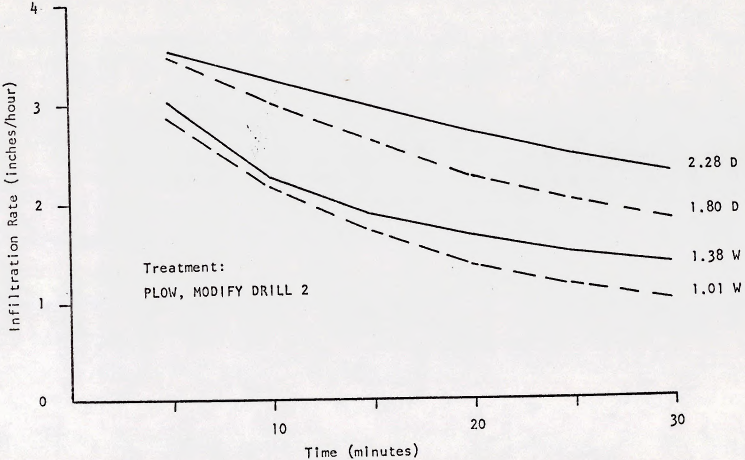

Figure 29.--Treatment No. 10. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

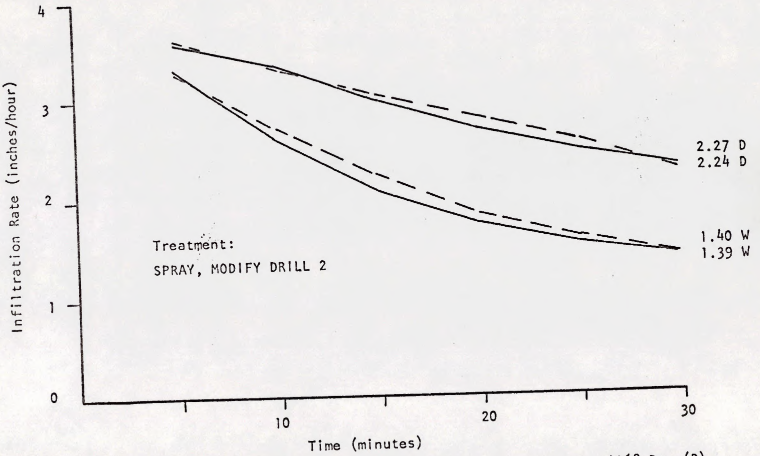

Figure 30.--Treatment No. 11. Average infiltration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower Site.

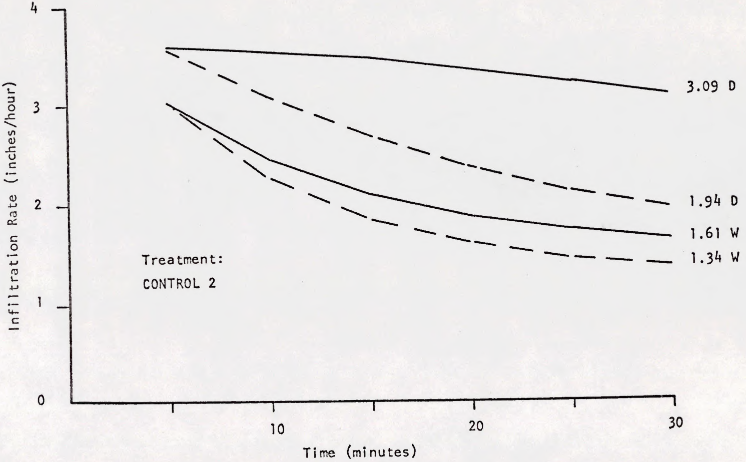

Figure 31.--Treatment No. 12. Average infilgration curves for 1968 Dry (D) and Wet (W) tests. Solid line represents Upper Site. Dashed line represents Lower site.

RESULTS AND DISCUSSION

The results of this study are discussed in five separate categories. These categories are as follows: the effects of time and site separated by treatment and moisture condition; the effects of treatments, sites, and moisture conditions; the effects of treatments separated by site and moisture condition; correlation analyses; and, regression analyses.

EFFECTS OF TIME AND SITE SEPARATED BY TREATMENT AND MOISTURE CONDITION:

The results of the one-way analysis of variance comparing sites and years by treatments and moisture condition are shown in Tables 4 through 8. Each value is the mean of four plots. The results are discussed below in separate sections for infiltration, water retention, and sediment production.

Infiltration:

The tabulated infiltration values (Tables 4 through 6) are illustrated in the infiltration curves (Figures 8 through 19). The tables include a total of 36 infiltration tests at each site (6 treatments X 2 conditions X 3 infiltration rates). Of these, 30 of the upper site 1966 to 1968 tests were significantly different at the 5 percent level while only 2 of the lower site 1966 to 1968 tests were significantly different at the 5 percent level. The data indicate that, infiltration rates increased at the upper site during the 1966 to 1968 period but not at the lower site. In general, the 1966 upper site infiltration rates were lower than the 1966 lower site infiltration rates. The infiltration rate increase at the upper site during the 1966 to 1968 period brought the upper site rates up to or above the lower site rates.

The author attributes the increased infiltration rates at the upper site to an increase in water holding capacity caused by an invasion of cheatgrass. This invasion was experienced on the control plots as well as on the treated plots. The effect on the control plots did not seriously damage the results of this study. However, future studies should be designed in such a way that an invasion of annuals on treated plots will have a minimum impact on control plots.

Water Retention:

Water retention at the lower site (Table 7) decreased between 1966 and 1968 (four out of 12 differences were significant). This decrease is most likely due to the disappearance of furrows and the sealing of plowed and drilled surfaces by raindrop impact and inwashing of fines.

Water retention at the upper site (Table 7) tended to increase between 1966 and 1968. However, only 1 out of 12 of the differences was significant. An examination of the upper site 30-minute infiltration rates (Table 6) indicates that 9 out of 12 of the differences were significant. This indicates that the 30-minute infiltration rate increase at the upper site is largely due to detaining water in the cheatgrass litter rather than retaining it in the soil profile. Field observations at the upper site indicated that water detained in the sponge-like litter continued to drain after the artificial precipitation stopped, thereby reducing the amount of water retention as compared to the 30-minute infiltration.

Sediment Production:

Very few 1966 to 1968 differences in sediment production were significant. This fact is not unusual as sediment production values are normally quite variable and large sample sizes are needed to obtain significant differences. The problem of sample size is discussed in more detail on page 78. Although most of the differences are not significant, a definite trend can be observed in Table 8. In almost every case between 1966 and 1968, sediment production increased slightly at the lower site and decreased slightly at the upper site.

The decrease in sediment production at the upper site may be attributed to improved soil structure and the presence of grass and litter. The increase in sediment production at the lower site is not easily explained. It may, in fact, be due to a procedural difference. The 1966 sediment production values were expanded from samples of sediment-laden water. Because the soils and thus the sediment at the lower site are very sandy, sediment settling in the mixed sediment-laden water would be very rapid, making it very difficult to collect a representative sample. In 1968 the sediment was allowed to settle and the entire amount of sediment produced was dried and weighed. This difference may have caused higher recordings in 1968 than in 1966. If it did, then the decrease in sediment production at the upper site is greater than the measurements indicate.

Table 4.--Mean infiltration rates after 10 minutes (I10) in inches per hour by year, site, plot condition, and treatment.

		1966		1968	
Treatment	Condition	U. S.	L. S.	U. S.	L. S.
01	dry	2.65 b	3.70 a	3.51 a	3.42 a
01	wet	1.50 c	3.49 a	2.81 b	3.03 ab
02	dry	3.16 a	2.55 a	3.55 a	3.14 a
02	wet	1.22 bc	1.66 bc	3.30 a	2.37 b
03	dry	2.90 b	3.64 a	3.53 a	3.44 ab
03	wet	1.67 b	2.29 ab	2.87 a	3.04 a
04	dry	3.40 a	3.31 a	3.54 a	3.47 a
04	wet	1.92 b	2.58 ab	3.27 a	2.94 ab
05	dry	2.97 b	3.60 a	3.54 a	3.45 a
05	wet	1.70 b	3.22 a	3.06 a	3.16 a
06	dry	2.37 b	3.52 a	3.54 a	3.10 a
06	wet	0.87 b	1.63 b	2.92 a	2.38 a

In any one row, values with the same subscript are not significantly different at the 5-percent probability level. Treatments: 01 = RD1; 02 = PMD1; 03 = C1; 04 = SMD1; 05 = SD1; 06 = PD1.

Table 5.--Mean infiltration rates after 20 minutes (I20) in inches per hour by year, site, plot condition, and treatment.

Treatment	Condition	1966 U. S.	1966 L. S.	1968 U. S.	1968 L. S.
01	dry	1.89 b	3.36 a	3.23 a	3.15 a
01	wet	1.31 b	2.52 a	2.36 a	2.52 a
02	dry	1.74 b	1.96 ab	3.48 a	2.56 ab
02	wet	0.96 c	1.17 bc	2.91 a	1.71 b
03	dry	1.90 b	2.88 a	3.35 a	3.02 a
03	wet	1.43 a	1.85 a	2.39 a	2.47 a
04	dry	2.64 b	2.51 b	3.44 a	3.23 ab
04	wet	1.56 b	2.15 ab	3.02 a	2.44 ab
05	dry	2.37 b	3.20 a	3.35 a	3.24 a
05	wet	1.59 b	2.94 a	2.66 a	2.82 a
06	dry	1.35 b	2.71 a	3.39 a	2.61 a
06	wet	0.87 c	1.43 bc	2.43 a	1.80 ab

In any one row, values with the same subscript are not significantly different at the 5-percent probability level. Treatments: 01 = RD1; 02 = PMD1; 03 = C1; 04 = SMD1; 05 = SD1; 06 = PD1.

Table 6.--Mean infiltration rates after 30 minutes (I30) in inches per hour by year, site, plot condition, and treatment.

		1966		1968	
Treatment	Condition	U. S.	L. S.	U. S.	L. S.
01	dry	1.76 b	2.98 a	3.00 a	2.93 a
01	wet	1.30 b	2.35 a	2.14 ab	2.22 a
02	dry	1.60 b	1.72 b	3.40 a	2.31 b
02	wet	0.92 b	1.14 b	2.71 a	1.43 b
03	dry	1.45 b	2.59 a	3.15 a	2.80 a
03	wet	1.36 a	1.78 a	2.16 a	2.22 a
04	dry	2.37 ab	2.24 b	3.34 a	3.06 a
04	wet	1.56 b	1.90 b	2.91 a	2.21 ab
05	dry	1.96 b	3.03 a	3.17 a	3.08 a
05	wet	1.59 b	2.91 a	2.48 ab	2.63 a
06	dry	1.18 b	2.60 a	3.16 a	2.35 a
06	wet	0.87 b	1.43 ab	2.20 a	1.54 ab

In any one row, values with the same subscript are not significantly different at the 5-percent probability level. Treatments: 01 = RD1; 02 = PMD1; 03 = C1; 04 = SMD1; 05 = SD1; 06 = PD1.

Table 7.--Mean inches of artificial precipitation retained (INR) on plot by year, site, plot condition, and treatment.

		1966		1968	
Treatment	Condition	U. S.	L. S.	U. S.	L. S.
01	dry	1.35 a	1.65 a	1.56 a	1.40 a
01	wet	1.03 b	1.15 a	1.11 b	1.02 b
02	dry	1.32 b	1.29 b	1.77 a	1.07 b
02	wet	0.96 b	1.02 a	1.40 a	0.62 b
03	dry	1.39 a	1.54 a	1.63 a	1.33 a
03	wet	1.10 a	1.24 a	1.12 a	1.03 a
04	dry	1.54 a	1.54 a	1.74 a	1.38 b
04	wet	1.22 ab	1.32 ab	1.51 a	1.02 b
05	dry	1.45 a	1.70 a	1.64 a	1.48 a
05	wet	1.13 b	1.55 a	1.28 ab	1.24 ab
06	dry	1.24 a	1.50 a	1.64 a	1.10 b
06	wet	0.79 ab	1.03 ab	1.14 a	0.68 b

In any one row, values with the same subscript are not significantly different at the 5-percent probability level. Treatments: 01 = RD1; 02 = PMD1; 03 = C1; 04 = SMD1; 05 = SD1; 06 = PD1.

Table 8.--Mean suspended sediment (tons per acre) by site, year, plot condition and treatment.a/

		1966		1968	
Treatment	Condition	U. S.	L. S.	U. S.	L. S.
01	dry	0.98 a	0.02 b	0.42 ab	0.25 ab
01	wet	1.79 a	0.24 c	0.66 bc	1.24 ab
02	dry	0.84 a	1.51 a	0.19 b	2.76 a
02	wet	1.49 ab	1.95 ab	0.24 b	3.04 a
03	dry	0.34 a	0.30 a	0.38 a	0.83 a
03	wet	1.86 a	1.03 a	0.81 a	1.30 a
04	dry	0.24 b	0.12 b	0.21 b	0.96 a
04	wet	0.98 a	1.00 a	0.48 a	1.50 a
05	dry	0.11 a	0.05 a	0.38 a	0.28 a
05	wet	0.48 a	0.25 a	0.32 a	0.45 a
06	dry	1.82 a	0.44 a	0.35 a	2.15 a
06	wet	3.56 a	1.28 a	0.69 a	3.11 a

In any one row, values with the same subscript are not significantly different at the 5-percent probability level. Treatments: 01 = RD1; 02 = PMD1; 03 = C1; 04 = SMD1; 05 = SD1; 06 = PD1.

a/ These sediment values include material transported completely through the collection system. Material deposited within the collection system was not measured in the 1966 test and is therefore not included in the 1966 or 1968 data of this table. See Tables 27 and 28 for total sediment production during the 1968 tests.

EFFECTS OF TREATMENTS, SITES, AND MOISTURE CONDITONS:

The results of the three-way analysis of variance of treatment, site, and moisture condition influences on the avereage infiltration rates after 10-, 20, and 30-minutes, the average inches of water retained on the plot and the average total sediment produced for the 1968 infiltration tests are shown in Tables 9 through 18. The results are discussed below in separate sections for infiltration, water retention and sediment production.

Infiltration:

The average 10-minute infiltration rate (Tables 9 and 10) for both sites and moisture conditions varied from 3.31 to 2.59 inches per hour. The average 20-minute infiltration rate (Tables 11 and 12) varied from 3.03 to 1.76 inches per hour. The average 30-minute infiltration rate (Tables 13 and 14) varied from 2.88 to 1.32 inches per hour.

Tables 9, 11, and 13 rank the 10, 20, and 30-minute infiltration rates in decreasing order. A consistent trend is readily seen in these tables. That is, plots that were treated in 1965 only (Treatments 01 through 06) had consistently higher average infiltration rates than plots that were treated in 1965 and retreated in 1967 (Treatments 07 through 11). Treatments 03 and 12 are controls and will be discussed below.

Within the upper-half of each table (Tables 9, 11, and 13) Treatments 04 and 05 are at the top (higher infiltration rates) and Treatments 02 and 06 are at the bottom (lower infiltration rates). Treatments 04 and 05 used herbicide for sagebrush eradication and Treatments 02 and 06 used plowing techniques to eradicate the sagebrush. Although not significantly different except in occasional places the plots

plowed in November 1965 had lower average infiltration rates than any of the other plots treated in 1965 only. And, the 1965 sprayed plots had consistently higher infiltration rates than any other treatments including the control (Treatment 03) plots.

Within each table the plots plowed in 1965 and retreated in 1967 (Treatments 09 and 10) consistently had the lowest infiltration rates.

Treatments 03 and 12 are both control treatments. Treatment 03 was tested with the infiltrometer in 1966 while Treatment 12 was not. Otherwise, the two treatments should be the same. In every case (Tables 9, 11, and 13) Treatment 03 had a significantly higher infiltration rate than did Treatment 12. This leads one to conclude that the infiltration tests in 1966 brought about a significant improvement in infiltration rate on control plots when tested two years later. During the 1966 infiltration tests the tested control plots retained an average of 2.74 inches at the lower site and an average of 2.49 inches at the upper site (Table 7). It is debatable whether this amount of water could significantly change the plot conditions to provide an improvement in infiltration rates. Tables 40 through 50 show various measures of 1968 ground cover for each treatment. In almost every case, Treatment 03 has more but not significantly more ground cover than Treatment 12.

The effects of site and moisture condition on infiltration are shown in Tables 10, 12 and 14. Site differences (wet and dry combined) were not significant for the 10-minute infiltration rate (Test No. 1, Table 10) but were highly significant for the 20 and 30-minute infiltration tests (Test No. 1, Tables 12 and 14). Dry plot

condition site differences were significant for the 10-minute infiltration rate (Test No. 2, Table 10) and highly significant for the 20 and 30-minute infiltration rates (Test No. 2, Tables 12 and 14). Wet plot condition site differences were not significantly different for any of the infiltration rates (Test No. 3, Tables 10, 12, and 14). Plot moisture condition differences (dry or wet, both sites combined) were highly significant for all of the infiltration rates (Test No. 4, Tables 10, 12 and 14).

Water Retention:

As expected, the average amount of water retained by the plots (Tables 15 and 16) responded in a manner comparable to the infiltration tests. The plots that were sprayed in 1965 and not retreated in 1967 (Treatments 04 and 05) retained the most water. The plots that were plowed in 1965 and retreated in 1967 (Treatments 09 and 10) retained the least water (Table 15).

All four tests shown in Table 16 were highly significant. These tests were (1) between sites with both moisture conditions combined, (2) between dry sites, (3) between wet sites, and (4) between moisture conditions with both sites combined.

Sediment Production:

The average 1968 sediment production by treatment (sites and conditions combined) varied from 0.61 to 2.33 tons per acre (Table 17). Of the four lowest sediment-producing treatments, one was the original control tested with the infiltrometer in 1966 (Treatment 03). The other three low-sediment producing treatments were treated in 1965 only (Treatments 01, 04, and 05). None of these three were among the plowed treatments. The 1965 plowed treatments (Nos. 02 and 06) were

among the four highest sediment-producing treatments. Excepting Treatment No. 04, the treatments utilizing the modified rangeland drill (Nos. 02, 10, and 11) were the highest sediment producers. This result is easily explained. During the infiltration tests many of the enlarged furrows were overtopped. When a furrow became overtopped a rivulet formed which rapidly cut a channel through the interfurrow area. The result was a small torrent which yielded relatively large amounts of sediment.

Freshly drilled (standard baby rangeland drill) plots tended to react in a similar, though less severe, manner. The smaller furrows were overtopped earlier during the tests and the subsequent runoff was more uniform with less "torrential" flow.

The effects of site and moisture condition on sediment production are shown in Table 18. The four tests were significant or highly significant indicating that these factors were influential in controlling sediment production. Sediment production was greatest from the lower site wet tests and least from the upper site dry tests. In general, one would think that the dry tests would free the plot of loose surface material and that the potential for erosion would be less during the wet test. Sediment production per inch of runoff was generally greater from the dry test than from the wet test. This indicates that the increased wet test sediment production is primarily caused by the increased runoff.

Table 9.--Mean 1968 infiltration rates after 10 minutes (I10); both sites and moisture conditions combined. Values are in inches per hour.

Treatment No.	Treatment Code	Mean
04	SMD1	3.31 a
05	SD1	3.30 a
03	C1	3.22 ab
01	RD1	3.19 ab
02	PMD1	3.09 abc
11	SMD2	3.00 bc
06	PD1	2.99 bc
08	SD2	2.94 bcd
07	RD2	2.88 cd
12	C2	2.84 cd
10	PMD2	2.69 de
09	PD2	2.59 e

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 10.--Mean 1968 infiltration rates after 10 minutes (I10) by site and condition. Values are in inches per hour.

Test No.	Test Description	Mean	
1	Upper site dry and wet	3.04	NS
	Lower site dry and wet	2.97	
2	Upper site dry	3.42	*
	Lower site dry	3.28	
3	Upper site wet	2.66	NS
	Lower site wet	2.66	
4	Both sites dry	3.35	**
	Both sites wet	2.66	

* Values within individual test are significantly different at the 5-percent probability level.

** Values within individual test are significantly different at the 1-percent probability level.

NS Values within individual test are not significantly different at the 5-percent probability level.

Table 11.--Mean 1968 infiltration rates after 20 minutes (I20); both sites and moisture conditions combined. Values are in inches per hour.

Treatment No.	Treatment Code	Mean
04	SMD1	3.03 a
05	SD1	3.02 ab
01	RD1	2.82 abc
03	C1	2.80 abc
02	PMD1	2.67 bcd
06	PD1	2.55 cde
08	SD2	2.32 def
12	C2	2.29 def
07	RD2	2.24 def
11	SMD2	2.23 ef
10	PMD2	1.99 fg
09	PD2	1.76 g

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 12.--Mean 1968 infiltration rates after 20 minutes (I20) by site and condition. Values are in inches per hour.

Test No.	Test Description	Mean	
1	Upper site dry and wet	2.58	**
	Lower site dry and wet	2.37	
2	Upper site dry	3.03	**
	Lower site dry	2.77	
3	Upper site wet	2.12	NS
	Lower site wet	1.98	
4	Both sites dry	2.90	NS
	Both sites wet	2.05	

NS Values within individual test are not significantly different at the 5-percent probability level.

** Values within individual test are significantly different at the 1 percent probability level.

Table 13.--Mean 1968 infiltration rates after 30 minutes (I30); both sites and moisture conditions combined. Values are in inches per hour.

Treatment No.	Treatment Code	Mean
04	SMD1	2.88 a
05	SD1	2.84 a
03	C1	2.58 ab
01	RD1	2.57 ab
02	PMD1	2.46 ab
06	PD1	2.31 bc
12	C2	1.99 cd
08	SD2	1.98 cd
07	RD2	1.88 d
11	SMD2	1.83 d
10	PMD2	1.62 de
09	PD2	1.32 e

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 14.--Mean 1968 infiltration rates after 30 minutes (I30) by site and condition. Values are in inches per hour.

Test No.	Test Description	Mean	
1	Upper site dry and wet	2.32	**
	Lower site dry and wet	2.05	
2	Upper site dry	2.77	**
	Lower site dry	2.42	
3	Upper site wet	1.88	NS
	Lower site wet	1.68	
4	Both sites dry	2.60	**
	Both sites wet	1.78	

** Values within individual test are significantly different at the 1-percent probability level.

NS Values within individual test are not significantly different at the 5-percent probability level.

Table 15.--Mean 1968 inches of artificial precipitation retained (INR) on plot; both sites and moisture conditions combined.

Treatment No.	Treatment Code	Mean
05	SD1	1.41 a
04	SMD1	1.41 a
03	C1	1.28 ab
01	RD1	1.27 ab
02	PMD1	1.21 ab
06	PD1	1.14 bc
12	C2	0.97 cd
08	SD2	0.96 cd
07	RD2	0.91 d
11	SMD2	0.87 d
10	PMD2	0.78 de
09	PD2	0.62 e

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 16.--Mean 1968 inches of artificial precipitation retained (INR) by site and condition.

Test No.	Test Description	Mean	
1	Upper site dry and wet	1.21	**
	Lower site dry and wet	0.93	
2	Upper site dry	1.43	**
	Lower site dry	1.12	
3	Upper site wet	0.98	**
	Lower site wet	0.74	
4	Both sites dry	1.28	**
	Both sites wet	0.86	

** Values within individual test are significantly different at the 1-percent probability level.

Table 17.--Mean 1968 total sediment (SED) production (tons per acre); both sites and moisture conditions combined.

Treatment No.	Treatment Code	Mean
05	SD1	0.61 a
03	C1	0.98 ab
01	RD1	1.12 abc
04	SMD1	1.12 abc
08	SD2	1.72 bcd
09	PD2	1.78 bcd
12	C2	1.84 bcd
07	RD2	1.85 bcd
06	PD1	1.92 bcd
02	PMD1	1.97 bcd
10	PMD2	2.15 cd
11	SMD2	2.33 d

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 18.--Mean 1968 total sediment (SED) values (tons per acre) by site and condition.

Test No.	Test Description	Mean	
1	Upper site dry and wet	1.28	**
	Lower site dry and wet	1.96	
2	Upper site dry	1.02	*
	Lower site dry	1.59	
3	Upper site wet	1.53	**
	Lower site wet	2.32	
4	Both sites dry	1.30	**
	Both sites wet	1.93	

* Values within individual test are significantly different at the 5-percent probability level.

** Values within individual test are significantly different at the 1-percent probability level.

EFFECTS OF TREATMENTS SEPARATED BY SITE AND MOISTURE CONDITION:

The results of the one-way analysis of variance of treatment effects on infiltration, water retention, and sediment production are shown in Tables 19 through 28. Each value is the mean of four plots. The results are discussed below in separate sections for infiltration, water retention, and sediment production.

Infiltration:

Treatment effects on dry and wet infiltration rates are shown in Tables 19 through 24.

The average dry 10-minute infiltration rates (Table 19) varied from 3.55 to 3.18 inches per hour at the upper site and from 3.48 to 3.00 inches per hour at the lower site. There were no significant differences in the dry 10-minute infiltration rates at either site.

The average wet 10-minute infiltration rates (Table 22) varied from 3.30 to 1.99 inches per hour at the upper site and from 3.16 to 2.05 inches per hour at the lower site. Significant differences were present under these conditions. At the lower site the plowed plots tended to have lower infiltration rates than the sprayed and ripped plots. At the upper site the plots treated in 1965 and 1967 had lower infiltration rates than plots treated in 1965 only. The plots plowed in 1965 only had relatively high infiltration rates because of a dense cheatgrass cover. The upper site plots that were treated in 1965 and 1967 had less cheatgrass. The treated lower site plots had very little cover.

The average dry 20-minute infiltration rates (Table 20) varied from 3.48 to 2.45 inches per hour at the upper site and from 3.24 to

2.04 inches per hour at the lower site. Significant differences were present under these conditions. In general, the trends discussed above for the 10-minute wet infiltration rates are present in this table.

The average wet 20-minute infiltration rates (Table 23) varied from 3.02 to 1.26 inches per hour at the upper site and from 2.82 to 1.12 inches per hour at the lower site. Significant differences were present under these conditions. Again, the trends discussed above for the 10-minute wet infiltration rates are present in this table.

The average dry 30-minute infiltration rates (Table 21) varied from 3.40 to 2.05 inches per hour at the upper site and from 3.08 to 1.48 inches per hour at the lower site. Significant differences were present under these conditions. The same trends, described for the 10-minute wet infiltration rates, are present in this table.

The average wet 30-minute infiltration rates (Table 24) varied from 2.91 to 0.95 inches per hour at the upper site and from 2.63 to 0.78 inches per hour at the lower site. Significant differences between the treatments were present. The trends discussed for the 10-minute wet infiltration rates are present in this table.

In general, plowed plots and plots that utilized the modified baby rangeland drill had lower infiltration rates than the control, ripped, or sprayed plots. This trend was more evident at the lower site, where no protective cover was established, than at the upper site where a heavy invasion of cheat grass masked treatment differences.

Water Retention:

The average amounts of water retained by the treatments are shown in Tables 25 and 26. The average amounts retained by the treatments after the dry tests (Table 25) varied from 1.06 to 1.77 inches at the

upper site and from 0.63 to 1.48 inches at the lower site. The average amounts retained by the treatments after the wet tests (Table 26) varied from 0.50 to 1.51 inches at the upper site and from 0.28 to 1.24 inches at the lower site.

At both sites, plots that were plowed and drilled in 1965 and drilled or plowed and drilled in 1967 retained the least amount of water after the dry test and were among the lowest after the wet test. The control plots that were not tested with the infiltrometer in 1966 also retained low amounts of water, thus supporting the idea that prior infiltration tests may improve the infiltration and water retention properties of a site.

Sediment Production:

The average total sediment production values for the 1968 tests are shown in Tables 27 and 28. The average sediment production during the 1968 dry tests varied from 0.22 to 2.32 tons per acre at the upper site and from 0.63 to 3.52 tons per acre at the lower site (Table 27). The sediment production from the 1968 wet tests varied from 0.48 to 2.68 tons per acre at the upper site and from 0.78 to 3.82 tons per acre at the lower site (Table 28).

At the upper site, sediment production tended to be greatest from the plowed plots and, at the lower site where there was no fresh plowing, the sediment production tended to be greater from the plots treated with the modified baby rangeland drill. Both cases support the long-recognized concept that soil disturbance increases sediment production.

Sample Size:

The 30-minute infiltration rates (Tables 21 and 24) and the sediment values (Tables 27 and 28) indicate a high degree of variability

with few significant differences. Part of the problem is associated with the normality of the data. When data is not normally distributed, one tends to reject the null hypothesis more frequently than when it is normally distributed. And, significance tests and confidence bands must be considered as approximations. A second part of the problem is that this study used only four replicates. In this light, some estimates of required sample size were obtained.

These estimates are made with an assumed need to detect differences, regardless of direction, of 1.0 tons per acre of sediment (or, 0.5 inches per hour for the average 30-minute infiltration rate) at the 95 percent level with a 90 percent assurance of detecting a true difference of this size.

The error mean squares (tons per acre) for the four sediment tests in Tables 27 and 28 are as follows: LSD, 1.56; LSW, 2.73; USD, 1.15; and, USW, 1.09. The corresponding required number of replicates are: LSD, 33; LSW, 58; USD, 25; and, USW, 23.

The error mean squares (inches per hour) for the four 30-minute infiltration tests in Tables 21 and 24 are: LSD, 0.34; LSW, 0.28; USD, 0.24; and, USW, 0.18. The corresponding required number of replicates are LSD, 15; LSW, 12; USD, 11; and, USW, 8.

The variability among treatments suggests that future studies would require fewer replicates if paired observations were used. Each plot would be tested with the infiltrometer both before and after treatment, thus eliminating the variance that exists between pairs.

Table 19.--Mean dry 1968 infiltration rates after 10 minutes (I10) by site and treatment. Rates are in inches per hour.

Upper site treatment no.	Upper site treatment code	Upper site mean		Lower site treatment no.	Lower site treatment code	Lower site mean	
02	PMD1	3.55	a	08	SD2	3.48	a
06	PD1	3.54	a	04	SMD1	3.47	a
05	SD1	3.54	a	05	SD1	3.45	a
04	SMD1	3.54	a	03	C1	3.44	a
03	C1	3.53	a	01	RD1	3.42	a
12	C2	3.53	a	07	RD2	3.36	a
01	RD1	3.51	a	11	SMD2	3.32	a
11	SMD2	3.34	a	02	PMD1	3.14	a
09	PD2	3.32	a	06	PD1	3.10	a
10	PMD2	3.26	a	12	C2	3.10	a
07	RD2	3.20	a	10	PMD2	3.04	a
08	SD2	3.18	a	09	PD2	3.00	a

Within any column, mean values with the same subscript are not significantly different at the 5-percent probability level.

Table 20.--Mean dry 1968 infiltration rates after 20 minutes (I20) by site and treatments. Rates are in inches per hour.

Upper site no.	Upper site treatment code	Upper site mean		Lower site no.	Lower site treatment code	Lower site mean	
02	PMD1	3.48	a	05	SD1	3.24	a
04	SMD1	3.44	a	04	SMD1	3.23	a
06	PD1	3.39	ab	01	RD1	3.15	a
03	C1	3.35	ab	08	SD2	3.14	a
05	SD1	3.35	ab	03	C1	3.02	ab
12	C2	3.34	ab	11	SMD2	2.80	abc
01	RD1	3.23	abc	07	RD2	2.80	abc
10	PMD2	2.68	bcd	06	PD1	2.61	abc
11	SMD2	2.68	bcd	02	PMD1	2.56	abc
09	PD2	2.60	cd	12	C2	2.36	abc
07	RD2	2.56	cd	10	PMD2	2.24	bc
08	SD2	2.45	d	09	PD2	2.04	c

Within any column, mean values with the same subscript are not significantly different at the 5-percent probability level.

Table 21.--Mean dry 1968 infiltration rates after 30 minutes (I30) by site and treatment. Rates are in inches per hour.

Upper site treatment no.	code	mean		lower site treatment no.	code	mean	
02	PMD1	3.40	a	05	SD1	3.08	a
04	SMD1	3.34	a	04	SMD1	3.06	a
05	SD1	3.17	a	01	RD1	2.93	a
06	PD1	3.16	a	03	C1	2.80	ab
03	C1	3.15	a	08	SD2	2.77	abc
12	C2	3.09	a	07	RD2	2.38	abcd
01	RD1	3.00	ab	06	PD1	2.35	abcd
10	PMD2	2.28	bc	02	PMD1	2.31	abcd
11	SMD2	2.27	bc	11	SMD2	2.24	abcd
07	RD2	2.19	c	12	C2	1.94	bcd
09	PD2	2.08	c	10	PMD2	1.80	cd
08	SD2	2.05	c	09	PD2	1.48	d

Within any column, mean values with the same subscript are not significantly different at the 5-percent probability level.

Table 22.--Mean wet 1968 infiltration rates after 10 minutes (I10) by site and treatment. Rates are in inches per hour.

Upper site treatment no.	code	mean		Lower site treatment no.	code	mean	
02	PMD1	3.30	a	05	SD1	3.16	a
04	SMD1	3.27	a	03	C1	3.04	ab
05	SD1	3.06	ab	01	RD1	3.03	ab
06	PD1	2.91	abc	04	SMD1	2.94	abc
03	C1	2.87	abcd	08	SD2	2.92	abc
01	RD1	2.81	abcd	07	RD2	2.80	abc
11	SMD2	2.62	abcde	11	SMD2	2.73	abcd
12	C2	2.47	bcde	06	PD1	2.38	bcd
10	PMD2	2.28	cde	02	PMD1	2.37	bcd
08	SD2	2.18	de	12	C2	2.27	cd
07	RD2	2.16	de	10	PMD2	2.19	d
09	PD2	1.99	e	09	PD2	2.05	d

Within any column, mean values with the same subscript are not significantly different at the 5-percent probability level.

Table 23.--Mean wet 1968 infiltration rates after 20 minutes (I20) by site and treatment. Rates are in inches per hour.

Upper site no.	Upper site treatment code	Upper site mean		Lower site no.	Lower site treatment code	Lower site mean	
04	SMD1	3.02	a	05	SD1	2.82	ab
02	PMD1	2.91	a	01	RD1	2.52	ab
05	SD1	2.66	a	03	C1	2.47	abc
06	PD1	2.43	ab	04	SMD1	2.44	abc
03	C1	2.39	ab	08	SD2	2.06	abcd
01	RD1	2.36	ab	07	RD2	2.02	abcd
12	C2	1.86	bc	11	SMD2	1.84	bcde
11	SMD2	1.73	bc	06	PD1	1.80	bcde
10	PMD2	1.66	c	02	PMD1	1.71	bcde
08	SD2	1.62	c	12	C2	1.60	cde
07	RD2	1.58	c	10	PMD2	1.38	de
09	PD2	1.26	c	09	PD2	1.12	e

Within any column, mean values with the same subscript are not significantly different at the 5-percent probability level.

Table 24.--Mean wet 1968 infiltration rates after 30 minutes (I30) by site and treatment. Rates are in inches per hour.

Upper site no.	treatment code	mean		lower site no.	treatment code	mean	
04	SMD1	2.91	a	05	SD1	2.63	a
02	PMD1	2.71	ab	01	RD1	2.22	ab
05	SD1	2.48	ab	03	C1	2.22	ab
06	PD1	2.20	abc	04	SMD1	2.21	ab
03	C1	2.16	bc	08	SD2	1.69	bc
01	RD1	2.14	bc	07	RD2	1.65	bc
12	C2	1.61	cd	06	PD1	1.54	bc
08	SD2	1.41	d	02	PMD1	1.43	bc
11	SMD2	1.39	d	11	SMD2	1.40	bc
10	PMD2	1.38	d	12	C2	1.34	bc
07	RD2	1.28	d	10	PMD2	1.02	c
09	PD2	0.95	d	09	PD2	0.78	c

Within any column, mean values with the same subscript are not significantly different at the 5-percent probability level.

Table 25.--Mean inches of water retained by the plots (INR) following the 1968 dry tests.

Upper site no.	Upper site treatment code	Upper site mean		Lower site no.	Lower site treatment code	Lower site mean	
02	PMD1	1.77	a	05	SD1	1.48	a
04	SMD1	1.74	ab	04	SMD1	1.46	a
06	PD1	1.64	ab	01	RD1	1.40	a
07	RD2	1.64	ab	03	C1	1.33	a
03	C1	1.63	ab	08	SD2	1.30	a
01	RD1	1.56	ab	07	RD2	1.11	ab
05	SD1	1.51	ab	06	PD1	1.10	ab
11	SMD2	1.19	abc	02	PMD1	1.07	ab
12	C2	1.16	abc	11	SMD1	1.02	ab
08	SD2	1.13	bc	12	C2	0.88	b
10	PMD2	1.08	c	10	PMD2	0.80	b
09	PD2	1.06	c	09	PD2	0.63	b

Within any column, mean values with the same subscript are not significantly different at the 5-percent probability level.

Table 26.--Mean inches of water retained by the plots (INR) following the 1968 wet tests.

Upper site no.	treatment code	mean		lower site no.	treatment code	mean	
04	SMD1	1.51	a	05	SD1	1.24	a
02	PMD1	1.40	ab	03	C1	1.03	ab
05	SD1	1.28	ab	01	RD1	1.02	ab
06	PD1	1.14	abc	04	SMD1	1.02	ab
03	C1	1.12	bc	08	SD2	0.74	bc
01	RD1	1.11	bc	07	RD1	0.73	bc
12	C2	0.84	cd	06	PD1	0.68	bdc
08	SD2	0.74	d	02	PMD1	0.62	bcd
10	PMD2	0.73	d	11	SMD2	0.59	bcd
11	SMD2	0.71	d	12	C2	0.56	cd
07	RD2	0.67	d	10	PMD2	0.39	cd
09	PD2	0.50	d	09	PD2	0.28	d

Within any column, mean values with the same subscript are not significantly different at the 5-percent probability level.

Table 27.--Total sediment production (tons per acre) from 1968 dry tests by site and treatment.

Upper site no.	Upper site treatment code	Upper site mean		lower site no.	lower site treatment code	lower site mean	
10	PMD2	2.32	a	02	PMD1	3.52	a
08	SD2	1.94	ab	06	PD1	2.56	ab
11	SMD2	1.80	ab	12	C2	2.14	ab
07	RD2	1.43	ab	10	PMD2	1.95	ab
09	PD2	1.39	ab	09	PD2	1.67	ab
12	C2	0.93	ab	11	SMD2	1.34	b
01	RD1	0.50	ab	04	SMD1	1.32	b
03	C1	0.46	b	01	RD1	1.26	b
05	SD1	0.46	b	03	C1	1.04	b
06	PD1	0.45	b	07	RD2	1.02	b
04	SMD1	0.31	b	08	SD2	0.96	b
02	PMD1	0.22	b	05	SD1	0.63	b

Within any column, mean value with the same subscript are not significantly different at the 5-percent probability level.

Table 28.--Total sediment production (tons per acre) from 1968 wet tests by site and treatment.

Upper site no.	treatment code	mean		lower site no.	treatment code	mean	
10	PMD2	2.68	a	06	PD1	3.82	a
08	SD2	2.64	a	11	SMD2	3.73	a
11	SMD2	2.48	ab	02	PMD1	3.64	a
07	RD2	2.43	ab	04	SMD1	2.26	ab
12	C2	2.28	abc	09	PD2	2.02	ab
09	PD2	1.74	abcd	12	C2	2.01	ab
03	C1	0.93	abcd	01	RD1	2.01	ab
06	PD1	0.85	bcd	10	PMD2	1.94	ab
01	RD1	0.70	cd	03	C1	1.48	ab
04	SMD1	0.58	cd	07	RD2	1.40	ab
05	SD1	0.58	cd	08	SD2	1.36	ab
02	PMD1	0.48	d	05	SD1	0.78	b

Within any column, mean values with the same subscript are n not significantly different at the 5-percent probability level.

CORRELATION ANALYSES:

Dependent Variables vs. Independent Variables:

Simple linear correlation analyses were conducted to analyze the effects of plant cover, soils, and microtopography on infiltration and sediment production. They were also used in a preliminary screening of potential independent variables for the development of regression prediction equations.

The simple linear correlation coefficients between selected dependent variables and independent variables are shown in Appendix D (Tables 56 through 63). The data represent the results obtained in 1968 and are separated by site and moisture condition. A pair of tables is presented for each site and moisture condition (LSD, USD, LSW, USW). The first table in each pair (Tables 56, 58, 60, and 62) show the actual correlation coefficients. The second table in each pair (Tables 57, 59, 61, and 63) indicates the significant and highly significant relationships (.05 and .01 significance levels). The following discussion is based on the above correlation coefficients and is separated into three areas: cover effects, soil profile effects, and micro-relief effects.

Cover Effects:

A review of the relationships between the independent cover variables (X23 through X36) and the dependent variables leads to the following observations. As bare ground (X33 and X34) increased infiltration decreased and sediment production increased at both sites and in both dry and wet conditions. As grass cover (X25, X26, or X27) increased at the upper site, infiltration and water retention

increased, and sediment production decreased. At the lower site a trend developed showing negative correlations between annual grass cover (X25) and infiltration. However, only one case was significant (I5 at LSD). A possible explanation for this seemingly unusual trend may be related to a disturbance factor which both decreased infiltration and increased the presence of annual grass. A cursory review of the effects of treatment on annual grass cover at the lower site supports this explanation. The total grass cover at the lower site was very low (averaging less than 3 percent). This amount would not be enough to increase infiltration by protecting the soil surface.

As rocks, 1/4 to 1-inch, on the soil surface (X31) increased, infiltration at the lower site decreased. And, surface rocks greater than 1-inch (X32) were negatively correlated with some infiltration rates at both sites. Normally, surface rocks protect the soil surface from raindrop impact and cause increased infiltration. The results obtained in this study are due, in part, to the fact that plant cover and litter which were positively correlated with infiltration were, in turn, negatively correlated with surface rock cover. Total ground cover (X36, prostrate vegetation, litter, and surface rocks combined) was positively correltaed with infiltration and negatively correlated with sediment production at both sites.

Soil Profile Effects:

Sand content in the first four inches (X44 and X48) showed positive correlations with infiltration and negative correlations with sediment production at the lower site. At the upper site, infiltration increased and sediment production decreased as the sand content in the

soil surface inch (X44) increased. During the USD test, infiltration decreased with increasing sand content in the soil 1 to 4-inch horizon.

At the upper site, infiltration rates after 20-minutes increased and sediment production decreased with increasing rock content in the surface inch (X37). Soils at this site are relatively fine textured. Winter frost heaving caused, in part, by water accumulated beneath these rocks may be increasing the profile porosity, thereby bringing about more rapid infiltration and, consequently, less sediment production.

Organic matter in the surface inch (X39) was positively correlated with infiltration at both sites and negatively correlated with sediment production at the upper site. Organic matter in the 1 to 4-inch horizon was not significantly correlated with the dependent variables.

Several measures of soil bulk density were obtained by the nuclear method. These were X41 (the back scatter method); X42 (transmission method through the 0 to 2-inch horizon); and, X43 (transmission method through the 0 to 4-inch horizon). In most cases these were not significantly correlated with the dependent variables. However, infiltration after 20 minutes during the LSW test did increase with bulk density in the 0 to 2-inch horizon (X42). This effect is probably related to a slight increase in bulk density associated with the sandier soils.

Micro Relief Effects:

Within the lower site, slope (X52) did not vary greatly. Thus, at the lower site, slope was not significantly correlated with the dependent variables. At the upper site, water retention, during both

and dry and wet tests, and infiltration after 20-minutes in the wet test increased with slope. The increased infiltration and water retention with increasing slope is probably related to the fact that on steeper slopes detached fine particles are carried downslope while on more gradual slopes the fines may settle out and seal the soil surface.

The surface roughness parameters (X53 and X54) were significantly correlated with increased sediment production at the lower site but not at the upper site. Surface roughness increased with site disturbance (i.e., plowing and drilling). During the 1968 infiltration tests, some furrows were overtopped. The rapid increase in runoff as the inter-furrow area was eroded caused visible increases in sediment production. A lesser amount of precipitation which does not overtop the furrows would probably yield less sediment production with increased surface roughness. The reason that surface roughness was not significantly correlated with sediment production at the upper site is that the disturbed plots at the upper site were invaded with cheatgrass. The cheatgrass invasion was greater on the 1965 treated plots than on the 1965 and 1967 treated plots. At the lower site very little vegetation was established on the disturbed plots.

Independent variables vs. independent variables:

The relationships between certain independent variables are sometimes of interest. Therefore, simple linear correlation coefficients between independent variables are shown in Appendix D (Tables 64 and 65). The coefficients are shown separately by site. In all cases, the independent variables are the same for both the dry and wet conditions. No discussion of these relationships will be presented in this paper.

REGRESSION ANALYSIS:

The soil-vegetation units represented in this study are typical of large areas in the Great Basin. Regression equations developed from this study may be useful to range resource managers in that they can aid in estimating precipitation excess, storm runoff, and sediment production from similar sites in the Great Basin.

The dependent variables developed in the following regression equations are: the average infiltration rates (inches per hour) after 10, 20, and 30 minutes (I10, I20, and I30); the inches of water retained on the plot after all surface runoff had ceased (INR); and the common logarithmic value of the total sediment production (LOGSED). The untransformed sediment data were in tons per acre. Details concerning the dependent and independent variables are shown in Table 31.

The regression equations presented below are separated by site and moisture condition. Within these categories each infiltration and water retention variable has two equations. The first is the best found simple linear equation, and the second is the multiple linear equation yielding the minimum standard error.

Four separate regression equations are shown for predicting the common logarithm of the total sediment production. The first two are the best simple linear and multiple linear regressions obtained while excluding runoff as an independent variable. The second group is similar except surface runoff (X22) was allowed to enter the equation. Accompanying each equation is the corresponding standard error of

estimate (S.E.) and the coefficient of determination (r^2 or R^2 depending on the equation).

A summary of the obtained simple linear (r^2) and multiple (R^2) coefficients of determination is shown in Table 29. Higher coefficients could have been obtained but at the expense of reduced degrees of freedom and higher standard errors.

A summary of standard errors obtained by the simple linear and multiple regression equations is shown in Table 30. Following each set of equations is a table summarizing the means and standard deviations of selected dependent variables (Tables 32, 33, 34, and 35). One can judge the effectiveness of the various regression equations by comparing the values in these tables with the standard errors obtained in the regression equations.

The equations presented below can not be expected to apply to storm and site conditions that are greatly different from those encountered in this study. Resource managers wishing to use these equations should satisfy themselves as to the similarity of site and storm conditions. The sites are described in Table 1 and Appendix A. A description of the artificial storm characteristics begins on page 12.

A third factor to consider before applying these equations is the overall improvement in the error estimate. In most cases the standard deviations of the overall mean are not much larger than the standard errors of the multiple regression equations. For example, consider the mean 30-minute infiltration rate for the lower site wet test. In this case the 48 samples indicate that at the 68.3 percent probability level the mean infiltration rate is between 0.98 and 2.38 inches per

Table 29.--A summary of the best simple linear (r^2) and multiple (R^2) coefficients of determination. a/

Variable	LSD r^2	LSD R^2	LSW r^2	LSW R^2	USD r^2	USD R^2	USW r^2	USW R^2
I10	0.259	0.428	0.317	0.572	0.405	0.580	0.559	0.722
I20	.419	.547	.426	.726	.613	.755	.626	.781
I30	.486	.674	.468	.759	.670	.748	.627	.787
INR	.524	.695	.484	.765	.677	.751	.682	.787
LOGSED w/o RO	.203	.416	.197	.570	.501	.636	.510	.700
LOGSED with RO	0.468	0.689	0.330	0.669	0.653	0.734	0.708	0.776

Infiltration rates for 10, 20, and 30 minute periods are shown as I10, I20, and I30; INR indicates inches of water retained on plot; LOGSED indicates the common log transformations of sediment production in one case with out runoff as a independent variable and in the other case with runoff as a independent variable.

a/ In this case the best R^2 value is defined as the R^2 value corresponding to the equation providing the minimum standard error.

Table 30.--A summary of standard errors for the regression equations obtained in this study. For each variable the first value is the standard error for the simple linear equation and the second value is the minimum standard error corresponding to the best obtained multiple regression equation. The units of the standard error are those of the dependent variables.

Variable	LSD	LSW	USD	USW
I10	0.257 .242	0.442 .390	0.190 .181	0.372 .325
I20	.462 .432	.511 .405	.369 .331	.412 .342
I30	.518 .454	.517 .399	.389 .374	.440 .357
INR	.257 .223	.263 .204	.199 .192	.226 .184
LOGSED w/o RO	.318 .285	.285 .230	.331 .311	.281 .236
LOGSED with RO	.260 0.210	.260 0.207	.276 0.250	.217 0.201

Infiltration rates for 10, 20, and 30 minutes are shown as I10, I20, and I30; units are inches per hour. INR value is inches of water retained on plot. LOGSED values are common log transformations of sediment production (tons per acre).

Table 31.--Selected independent and dependent variables used in developing refined prediction equations.a/

Variable		
Number	Code	Description
Y 5	I10	Average infiltration rate after 10-minutes (inches per hour)
Y 7	I20	Average infiltration rate after 20 minutes (inches per hour)
Y 9	I30	Average infiltration rate after 30-minutes (inches per hour)
Y10	INR	Water retained on plot (inches)
Y21	LOGSED	Common log of sediment production (tons per acre)
X22b/	SRO	Surface runoff (inches)
X28	TCA	Proportion total canopy cover (0-1)
X34	BG2	Proportion bare ground (0-1)
X37	RP1	Proportion rock > 2mm in surface inch of soil (0-1)
X39	OM1	Percent soil organic matter in surface inch of soil (0-100)
X42	BD1	Soil bulk density in 0-2 inch horizon (g/cc)
X44	SA1	Sand fraction in soil surface inch (0-1)
X48	SA2	Sand fraction in soil 1 to 4-inch horizon (0-1)
X52	SPE	Slope tangent
X54	ARF	Absolute roughness factor

a/ See Table 3 for more complete description of variables.
b/ Variable 22 was not used in equations for predicting infiltration or water retained on the plot.
c/ Variables 28 through 54 were used alone and as squared transformations.

LOWER SITE DRY EQUATIONS:

Average infiltration rate after 10 minutes:

$$I10 = 1.84 + (2.11)(X44) \qquad \text{(Eq. 1)}$$

$$S.E. = 0.257$$

$$r = 0.508$$

$$r^2 = 0.259$$

$$I10 = -4.90 + (0.934)(X37) + (16.0)(X44) + (7.56)(X48) - (6.06)(X52) - (0.375)(X34^2) - (10.5)(X44^2) - (5.53)(X48^2) \qquad \text{(Eq. 2)}$$

$$S.E. = 0.242$$

$$R = 0.654$$

$$R^2 = 0.428$$

Average infiltration rate after 20 minutes:

$$I20 = -0.957 + (5.44)(X44) \qquad \text{(Eq. 3)}$$

$$S.E. = 0.462$$

$$r = 0.647$$

$$r^2 = 0.419$$

$$I20 = -6.08 + (4.10)(X28) + (19.6)(X44) + (1.50)(X48) - (13.5)(X28^2) - (0.958)(X34^2) - (11.4)(X44^2) \qquad \text{(Eq. 4)}$$

$$S.E. = 0.432$$

$$R = 0.739$$

$$R^2 = 0.547$$

LOWER SITE DRY EQUATIONS (CONTINUED):

Average infiltration rate after 30 minutes:

$$I30 = -2.35 + (6.98)(X44) \qquad \text{(Eq. 5)}$$

$$S.E. = 0.518$$

$$r = 0.697$$

$$r^2 = 0.486$$

$$\begin{aligned} I30 = & -10.1 + (9.99)(X37) + (0.879)(X39) + (5.32)(X44) \\ & + (19.5)(X48) - (0.785)(X34^2) - (23.7)(X37^2) \\ & - (0.179)(X39^2) + (0.432)(X42^2) - (14.2)(X48^2) \qquad \text{(Eq. 6)} \end{aligned}$$

$$S.E. = 0.454$$

$$R = 0.821$$

$$R^2 = 0.674$$

Water retained on plot:

$$INR = -1.43 + (3.74)(X44) \qquad \text{(Eq. 7)}$$

$$S.E. = 0.257$$

$$r = 0.724$$

$$r^2 = 0.524$$

$$\begin{aligned} INR = & -4.38 + (4.82)(X37) + (0.304)(X39) + (3.14)(X44) \\ & + (8.52)(X48) - (0.535)(X34^2) - (11.0)(X37^2) \\ & - (0.0621)(X39^2) - (6.17)(X48^2) \qquad \text{(Eq. 8)} \end{aligned}$$

$$S.E. = 0.223$$

$$R = 0.834$$

$$R^2 = 0.695$$

LOWER SITE DRY EQUATIONS (CONTINUED):

Sediment production (runoff parameter not included):

$$LOGSED = 0.842 - (1.63)(X44^2) \qquad \text{(Eq. 9)}$$

$$S.E. = 0.318$$

$$r = 0.451$$

$$r^2 = 0.203$$

$$LOGSED = -4.87 + (18.5)(X44) - (47.8)(X52) + (0.928)(X34^2) - (14.7)(X44^2) + (476)(X52^2) \qquad \text{(Eq. 10)}$$

$$S.E. = 0.285$$

$$R = 0.645$$

$$R^2 = 0.416$$

Sediment production (runoff parameter included):

$$LOGSED = -0.402 + (0.655)(X22) \qquad \text{(Eq. 11)}$$

$$S.E. = 0.260$$

$$r = 0.684$$

$$r^2 = 0.468$$

$$LOGSED = -7.45 + (0.880)(X22) + (20.9)(X44) - (36.5)(X52) + (0.323)(X54) - (14.3)(X44^2) + (356)(X52^2) \qquad \text{(Eq. 12)}$$

$$S.E. = 0.210$$

$$R = 0.830$$

$$R^2 = 0.689$$

Table 32--Mean and standard deviation values for selected dependent variables at 1968 lower site dry test.

Number	name	mean	standard deviation
04	I5	3.57	0.093
05	I10	3.28	0.296
06	I15	2.99	0.483
07	I20	2.77	0.600
08	I25	2.58	0.671
09	I30	2.43	0.715
10	I10	1.12	0.368
21	SED	1.59	1.364
21	LOGSED	0.073	0.352

Infiltration rates for 5, 10, 15, 20, 25, and 30 minute periods are shown as I5, I10, etc.; units are inches per hour. INR is inches of water retained on plot. The SED value is sediment production in tons per acre. The LOGSED value is the common log of SED.

LOWER SITE WET EQUATIONS:

Average infiltration rate after 10 minutes:

$$I10 = -0.197 + (4.17)(X44) \qquad \text{(Eq. 13)}$$

$$S.E. = 0.442$$
$$r = 0.563$$
$$r^2 = 0.317$$

$$I10 = 3.81 + (6.05)(X28) - (1.65)(X34) + (1.12)(X42) - (14.5)(X44) + (3.45)(X54) - (17.2)(X28^2) - (2.14)(X37^2) + (13.3)(X44^2) - (94.9)(X52^2) - (1.57)(X54^2) \qquad \text{(Eq. 14)}$$

$$S.E. = 0.390$$
$$R = 0.756$$
$$R^2 = 0.572$$

Average infiltration rate after 20 minutes:

$$I20 = -0.128 + (4.46)(X44^2) \qquad \text{(Eq. 15)}$$

$$S.E. = 0.511$$
$$r = 0.652$$
$$r^2 = 0.426$$

$$I20 = 6.16 + (6.61)(X28) - (1.90)(X34) + (0.760)(X39) - (34.4)(X44) + (64.9)(X52) + (3.76)(X54) - (19.1)(X28^2) - (0.171)(X39^2) + (0.931)(X42^2) + (28.8)(X44^2) - (617)(X52^2) - (1.68)(X54^2) \qquad \text{(Eq. 16)}$$

$$S.E. = 0.405$$
$$R = 0.852$$
$$R^2 = 0.726$$

LOWER SITE WET EQUATIONS (CONTINUED):

Average infiltration rate after 30 minutes:

$$I30 = -0.647 + (4.92)(X44^2) \qquad \text{(Eq. 17)}$$

$$S.E. = 0.517$$

$$r = 0.684$$

$$r^2 = 0.468$$

$$\begin{aligned} I30 = {} & 6.24 + (5.54)(X28) + (0.719)(X39) - (38.9)(X44) \\ & + (84.4)(X52) + (3.61)(X54) - (16.5)(X28^2) \\ & - (1.86)(X34^2) - (0.171)(X39^2) + (0.991)(X42^2) \\ & + (32.4)(X44^2) - (768)(X52^2) - (1.62)(X54^2) \qquad \text{(Eq. 18)} \end{aligned}$$

$$S.E. = 0.399$$

$$R = 0.871$$

$$R^2 = 0.759$$

Water retained on plot:

$$INR = -0.479 + (2.58)(X44^2) \qquad \text{(Eq. 19)}$$

$$S.E. = 0.263$$

$$r = 0.696$$

$$r^2 = 0.484$$

$$\begin{aligned} INR = {} & 3.09 + (2.65)(X28) + (0.345)(X39) - (19.9)(X44) \\ & + (44.3)(X52) + (1.78)(X54) - (7.95)(X28^2) \\ & - (0.972)(X34^2) - (0.0840)(X39^2) + (0.506)(X42^2) \\ & + (16.7)(X44^2) - (399)(X52^2) - (0.793)(X54^2) \qquad \text{(Eq. 20)} \end{aligned}$$

$$S.E. = 0.204$$

$$R = 0.874$$

$$R^2 = 0.765$$

LOWER SITE WET EQUATIONS (CONTINUED):

Sediment production (runoff parameter not included):

$$LOGSED = -0.141 + (0.957)(X34^2) \quad \text{(Eq. 21)}$$

$$S.E. = 0.285$$
$$r = 0.443$$
$$r^2 = 0.197$$

$$\begin{aligned} LOGSED = {} & -6.68 - (2.87)(X34) - (1.15)(X37) + (22.8)(X44) \\ & - (3.58)(X28^2) + (3.23)(X34^2) - (17.1)(X44^2) \\ & - (0.317)(X48^2) + (55.7)(X52^2) + (0.0956)(X54^2) \quad \text{(Eq. 22)} \end{aligned}$$

$$S.E. = 0.230$$
$$R = 0.755$$
$$R^2 = 0.570$$

Sediment production (runoff parameter included):

$$LOGSED = -0.310 + (0.499)(X22) \quad \text{(Eq. 23)}$$

$$S.E. = 0.260$$
$$r = 0.574$$
$$r^2 = 0.330$$

$$\begin{aligned} LOGSED = {} & -6.74 + (0.498)(X22) - (3.11)(X34) - (1.10)(X37) \\ & + (0.841)(X42) + (16.0)(X44) + (5.29)(X52) \\ & + (0.255)(X54) - (4.17)(X28^2) + (2.91)(X34^2) \\ & - (0.00979)(X39^2) - (11.3)(X44^2) \quad \text{(Eq. 24)} \end{aligned}$$

$$S.E. = 0.207$$
$$R = 0.818$$
$$R^2 = 0.669$$

Table 33.--Mean and standard deviation values for selected dependent variables at 1968 lower site wet test.

Number	name	mean	standard deviation
04	I5	3.23	0.312
05	I10	2.66	0.529
06	I15	2.25	0.626
07	I20	1.98	0.668
08	I25	1.81	0.692
09	I30	1.68	0.702
10	INR	0.74	0.363
21	SED	2.23	1.732
21	LOGSED	0.243	0.315

Infiltration rates for 5, 10, 15, 20, 25, and 30 minutes are shown as I5, I10, etc.; units are in inches per hour. INR value is inches of water retained on plot. The SED value is sediment production in tons per acre. The LOGSED value is the common log of SED.

UPPER SITE DRY EQUATIONS:

Average infiltration rate after 10 minutes:

$$I10 = 3.58 - (0.791)(X34^2) \tag{Eq. 25}$$

$$S.E. = 0.190$$
$$r = 0.636$$
$$r^2 = 0.405$$

$$\begin{aligned} I10 = &- 0.080 + (0.866)(X34) + (0.814)(X39) - (5.19)(X42) \\ &+ (28.9)(X44) - (2.34)(X52) + (0.462)(X28^2) \\ &- (1.56)(X34^2) - (0.199)(X39^2) + (1.69)(X42^2) \\ &- (30.3)(X44^2) + (0.148)(X54^2) \end{aligned} \tag{Eq. 26}$$

$$S.E. = 0.181$$
$$R = 0.762$$
$$R^2 = 0.580$$

Average infiltration rate after 20 minutes:

$$I20 = 3.51 - (2.34)(X34^2) \tag{Eq. 27}$$

$$S.E. = 0.369$$
$$r = 0.783$$
$$r^2 = 0.613$$

$$\begin{aligned} I20 = &\ 0.681 + (3.42)(X28) + (1.24)(X34) - (9.52)(X42) + (39.7)(X44) \\ &- (3.54)(X28^2) - (3.33)(X34^2) + (3.01)(X37^2) + (2.96)(X42^2) \\ &-(41.4)(X44^2) - (16.8)(X52^2) + (0.284)(X54^2) \end{aligned} \tag{Eq. 28}$$

$$S.E. = 0.331$$
$$R = 0.869$$
$$R^2 = 0.755$$

UPPER SITE DRY EQUATIONS (CONTINUED):

Average infiltration rate after 30 minutes:

$$I30 = 3.34 - (2.80)(X34^2) \qquad \text{(Eq. 29)}$$

$$S.E. = 0.389$$

$$r = 0.819$$

$$r^2 = 0.670$$

$$\begin{aligned} I30 = 1.74 &+ (2.42)(X28) - (10.3)(X42) + (36.6)(X44) \\ &- (2.52)(X28^2) - (2.34)(X34^2) + (0.0295)(X39^2) \\ &+ (3.30\ )(X42^2) - (37.8)(X44^2) + (0.220)(X54^2) \qquad \text{(Eq. 30)} \end{aligned}$$

$$S.E. = 0.374$$

$$R = 0.865$$

$$R^2 = 0.748$$

Water retained on plot:

$$INR = 1.73 - (1.46)(X34^2) \qquad \text{(Eq. 31)}$$

$$S.E. = 0.199$$

$$r = 0.823$$

$$r^2 = 0.677$$

$$\begin{aligned} INR = 1.21 &+ (1.24)(X28) - (5.30)(X42) + (17.5)(X44) \\ &- (1.29)(X28^2) - (1.23)(X34^2) + (0.0161)(X39^2) \\ &+ (1.69)(X42^2) - (18.1)(X44^2) + (0.110)(X54^2) \qquad \text{(Eq. 32)} \end{aligned}$$

$$S.E. = 0.192$$

$$R = 0.867$$

$$R^2 = 0.751$$

UPPER SITE DRY EQUATIONS (CONTINUED):

Sediment production (runoff parameter not included):

$$LOGSED = -0.742 + (1.44)(X34) \qquad \text{(Eq. 33)}$$

$$S.E. = 0.331$$

$$r = 0.708$$

$$r^2 = 0.501$$

$$\begin{aligned} LOGSED = -5.16 &- (1.35)(X28) - (0.399)(X34) + (8.50)(X42) \\ &- (2.67)(X44) + (1.52)(X48) + (1.45)(X34^2) \\ &- (3.02)(X42^2) + (9.13)(X52^2) - (0.287)(X54^2) \qquad \text{(Eq. 34)} \end{aligned}$$

$$S.E. = 0.311$$

$$R = 0.798$$

$$R^2 = 0.636$$

Sediment production (runoff parameter included):

$$LOGSED = -0.623 + (1.08)(X22) \qquad \text{(Eq. 35)}$$

$$S.E. = 0.276$$

$$r = 0.808$$

$$r^2 = 0.653$$

$$\begin{aligned} LOGSED = -3.94 &+ (0.989)(X22) + (5.46)(X42) - (1.13)(X28^2) \\ &- (2.08)(X42^2) \qquad \text{(Eq. 36)} \end{aligned}$$

$$S.E. = 0.250$$

$$R = 0.856$$

$$R^2 = 0.734$$

Table 34.--Mean and standard deviation values for selected dependent variables at 1968 upper site dry test.

Number	name	mean	standard deviation
04	I5	3.57	0.040
05	I10	3.42	0.244
06	I15	3.23	0.427
07	I20	3.03	0.586
08	I25	2.89	0.624
09	I30	2.77	0.670
10	INR	1.43	0.347
21	SED	1.20	1.692
21	LOGSED	0.173	0.464

Infiltration rates for 5, 10, 15, 20, 25, and 30 minute periods are shown as I5, I10, etc.; units are in inches per hour. INR value is inches of water retained on plot. The SED value is sediment production in tons per acre. The LOGSED value is the common log of SED.

UPPER SITE WET EQUATIONS:

Average infiltration rate after 10 minutes:

$$I10 = 3.38 - (1.82)(X34) \qquad \text{(Eq. 37)}$$

$$S.E. = 0.372$$

$$r = 0.748$$

$$r^2 = 0.559$$

$$I10 = -3.30 + (0.896)(X28) - (1.42)(X34) + (0.183)(X39)$$

$$- (0.830)(X42) + (26.8)(X44) + (1.73)(X48)$$

$$- (2.89)(X52) - (26.9)(X44^2) + (0.384)(X54^2) \qquad \text{(Eq. 38)}$$

$$S.E. = 0.325$$

$$R = 0.850$$

$$R^2 = 0.722$$

Average infiltration rate after 20 minutes:

$$I20 = 3.03 - (2.32)(X34) \qquad \text{(Eq. 39)}$$

$$S.E. = 0.412$$

$$r = 0.791$$

$$r^2 = 0.626$$

$$I20 = 8.60 + (1.06)(X28) - (1.78)(X34) - (10.2)(X42)$$

$$+ (1.46)(X48) + (0.101)(X39^2) + (3.35)(X42^2)$$

$$+ (1.73)(X44^2) + (0.432)(X54^2) \qquad \text{(Eq. 40)}$$

$$S.E. = 0.342$$

$$R = 0.884$$

$$R^2 = 0.781$$

UPPER SITE WET EQUATIONS (CONTINUED):

Average infiltration rate after 30 minutes:

$$I30 = 2.86 - (2.49)(X34) \quad \text{(Eq. 41)}$$

$$S.E. = 0.440$$

$$r = 0.792$$

$$r^2 = 0.627$$

$$I30 = 8.26 + (1.27)(X28) - (1.67)(X34) - (10.0)(X42) + (0.112)(X39^2) + (3.34)(X42^2) + (2.52)(X44^2) + (0.534)(X54^2) \quad \text{(Eq. 42)}$$

$$S.E. = 0.357$$

$$R = 0.887$$

$$R^2 = 0.787$$

Water retained on plot:

$$INR = 1.48 - (1.28)(X34) \quad \text{(Eq. 43)}$$

$$S.E. = 0.226$$

$$r = 0.793$$

$$r^2 = 0.628$$

$$INR = 4.32 + (0.645)(X28) - (0.859)(X34) - (5.23)(X42) + (0.0586)(X39^2) + (1.75)(X42^2) + (1.28)(X44^2) + (0.270)(X54^2) \quad \text{(Eq. 44)}$$

$$S.E. = 0.184$$

$$R = 0.887$$

$$R^2 = 0.787$$

UPPER SITE WET EQUATIONS (CONTINUED):

Sediment production (runoff parameter not included);

$$LOGSED = -0.459 + (1.25)(X34) \qquad \text{(Eq. 45)}$$

$$S.E. = 0.281$$

$$r = 0.714$$

$$r^2 = 0.510$$

$$LOGSED = 0.0517 + (0.557)(X34) + (0.728)(X39) - (1.46)(X28^2) - (0.220)(X39^2) - (2.72)(X44^2) + (1.30)(X48^2) - (0.319)(X54^2) \qquad \text{(Eq. 46)}$$

$$S.E. = 0.236$$

$$R = 0.836$$

$$R^2 = 0.700$$

Sediment production (runoff parameter included):

$$LOGSED = -0.761 + (0.911)(X22) \qquad \text{(Eq. 47)}$$

$$S.E. = 0.217$$

$$r = 0.841$$

$$r^2 = 0.708$$

$$LOGSED = 0.258 + (0.618)(X22) - (1.80)(X44) - (1.17)(X28^2) + (1.37)(X48^2) + (5.80)(X52^2) - (0.201)(X54^2) \qquad \text{(Eq. 48)}$$

$$S.E. = 0.201$$

$$R = 0.881$$

$$R^2 = 0.776$$

Table 35.--Mean and standard deviation values for selected dependent variables at 1968 upper site wet test.

Number	name	mean	standard deviation
04	I5	3.21	0.319
05	I10	2.66	0.554
06	I15	2.33	0.626
07	I20	2.12	0.666
08	I25	1.98	0.694
09	I30	1.89	0.714
10	INR	0.98	0.367
21	SED	1.53	1.276
21	LOGSED	0.032	0.397

Infiltration rates for 5, 10, 15, 20, 25, and 30 minute periods are shown as I5, I10, etc.; units are inches per hour. INR value is inches of water retained on plot. The SED value is sediment production in tons per acre. The LOGSED value is the common log of SED.

hour (1.68 $\pm$ 0.70). The 12-variable multiple regression equation (Eq. 18) yielded an average standard error of 0.40 inches per hour. Thus, the same mean estimate (1.68) would have a range of 1.28 to 2.08 inches per hour at the 68.3 percent probability level. In many cases, the improvement in the estimate gained by using the regression equation will not be worth the trouble. This may be especially so when one considers that infiltration and sediment estimates are normally used in conjunction with precipitation data and that precipitation data is extremely variable in semiarid regions.

However, the author feels that some of these equations may become useful resource management tools. Therefore, it seems appropriate to present an example of how they might be used in a resource management situation. No claim of extreme accuracy is implied. Rather, the intention is to indicate a method of utilization.

Sample Problem:

The nature of the problem is to determine the precipitiation excess (runoff) from a 30-minute, 2-inch storm and to estimate the amount of soil loss that such a storm would produce for an area with characteristics similar to those found at the lower site of this study. A detailed analysis of the sample site characteristics indicates the following conditions:

1. Percent bare ground equals 40. Therefore, X34 equals 0.40.
2. The proportion of the material in the soil surface inch that is larger than 2 mm (X37) is 0.10.
3. The percent soil organic matter in the surface inch of soil (X39) is 1.0.

4. The soil bulk density of the 0-2-inch horizon (X42) is 1.8 g/cc.

5. The sand fraction of the soil surface inch (X44) is 0.6.

6. The sand fraction in the soil 1 to 4-inch horizon (X48) is 0.45.

Substituting the above variables into equation number six provides a 30-minute average infiltration rate of 1.73 inches per hour or 0.86 inches in 30 minutes. Subtractin the 0.86 inches from the total storm precipitation yields 1.14 inches of precipitation excess or runoff.

Equation number 11 can now be used to provide a soil loss estimate of 2.2 tons per acre. A disadvantage of using this equation is that the error of estimate included in the runoff parameter will increase the error of estimate for the soil erosion loss. An alternative method would be to use equation number 12. However, this would require information about slope (X52) and surface roughness. (X54).

CONCLUSIONS

One of the objectives of this study called for evaluating the effectiveness of various range cultural practices in reducing sediment production and overland flow from marginal big sage sites in the Eastgate Basin. Perennial grass survival was too low to permit an evaluation of a successful conversion. Thus, this study evaluated some hydrologic effects of an unsuccessful attempt to establish perennial grasses on marginal sites. The following points are concluded from the analysis of variances tests in this study:

1. After three years (1965 to 1968) plowed plots had lower infiltration rates than control plots. Sprayed plots had slightly higher infiltration rates than the control plots. The infiltration rates on the rip and drill plots were approximately the same as those on the control plots. These results are consistent with the first year results of Gifford (1968a) and Gifford and Skau (1967). They are also in agreement with Tigerman (1952). They support the long recognized fact that plowing and certain other forms of soil disturbance can reduce infiltration.
2. After three years (1965 to 1968) plowed plots and plots using the modified baby rangeland drill yielded more sediment. In general, plots that were drilled with the modified baby rangeland drill tended to yield higher sediment values than those that were drilled with the standard baby rangeland drill. The larger furrows worked fine until their capacity was exceeded. Then it became evident that the site would have been better off without them. The problem would be accentuated

on long slopes as water from overtopped furrows would concentrate as it moved downslope.

3. Sediment production (1968) varied significantly with plot moisture condition. Sediment production was greater from the wet tests than from the dry tests. The data indicate that this increase is due to increased runoff rather than aggregate stability.
4. The 1968 sediment production was greater from the deep, sandy, unprotected soils at the lower site than it was from the shallower, more compact soils with dense cheatgrass cover at the upper site. In 1966, prior to the cheatgrass invasion at the upper site, the upper site produced more sediment than the lower site.
5. Infiltration rates at the lower site did not increase between 1966 and 1968, but did do so at the upper site. The lack of change at the lower site is due, in part, to the fact that the 1966 rates were already relatively high and that little protective cover was established between 1966 and 1968. The increase at the upper site is assumed to be a result of cheatgrass invasion.
6. In general, infiltration on the treated plots was less at the lower site than at the upper site. This is a reversal of the trend found in 1966 (prior to the invasion of cheatgrass at the upper site). When both dry and wet moisture conditions were combined, the 1968 infiltration rates differed by site after 10 minutes. When the dry tests were considered by themselves, the 10, 20, and 30-minute infiltration rates differed by sites.

When the wet tests were considered by themselves, infiltration rates did not differ significantly between sites.

7. There is evidence that water applied during an early infiltration test can improve plot conditions and thereby cause later infiltration tests to record more infiltration and less sediment. It was observed that the control plots tested with the infiltrometer in 1966 had higher infiltration rates and produced less sediment in 1968 than the control plots that were not tested in 1965.

8. Future studies of this nature should consider the variability of the data encountered in this study. The data obtained in this study indicate trends but do not provide much confidence in terms of statistical significance.

A second phase of this study used simple linear correlation analyses to examine some influences of plot characteristics on infiltration and sediment production. Some of the more visible relationships are presented below. A more detailed discussion is presented in the text. Specific correlation coefficients can be found in Appendix D.

1. Infiltration increased and sediment production decreased with decreasing bare ground.

2. The presence of annual grasses increased infiltration and reduced sediment production at the upper site.

3. Infiltration increased and sediment production decreased as the sand content of the soil surface inch increased.

4. The presence of rocks greater than 2 mm in size in the soil surface inch was positively correlated with infiltration at the upper site but not at the sandy lower site.

5. Infiltration increased with increasing organic matter content in the soil surface inch.
6. Surface roughness as recorded, by the microrelief parameters, was not significantly correlated with infiltration. Sediment production at the lower site increased with surface roughness (a result of treatment disturbances). Sediment production at the upper site was not significantly correlated with surface roughness. The presence of cheatgrass may have masked the effects of surface roughness at the upper site.

A third objective was to attempt to develop useful regression prediction equations for several dependent variables. Equations were developed for the average infiltration rates after 10, 20, and 30-minutes; for the inches of water retained by the plots; and for sediment production during the runoff period. The equations and a sample problem are presented in the text. Several tables are included which allow the reader to judge the effectiveness of the equations by comparing the equation standard error with the standard deviations of the dependent variables. The infiltration multiple regression equations all have standard errors of 0.5 inches per hour or less. The standard deviations of the overall sample means are only slightly larger. A resource manager may prefer to use the overall sample mean and standard deviation values as opposed to applying the regression equations to estimate infiltration rates or sediment production. This may be justified when one realizes that infiltration and sediment estimates are usually used in conjunction with precipitation data and that average precipitation estimates are subject to large errors, especially in semiarid regions.

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APPENDIX A

SOIL DESCRIPTIONS

This appendix contains soil profile descriptions for both sites. The descriptions were made using the procedures outlined in the Soil Survey Manual (U.S.D.A., 1951) and the Seventh Approximation plus revisions (U.S.D.A., 1960, 1967, 1970).

LOWER SITE:

This soil is classified as a coarse loamy, mixed, mesic family of Typic Camborthids. This soil has a 10 inch ochric epipedon over a massive, sandy loam cambic horizon. Reaction of the solum increases with depth and ranges from neutral to mildly alkaline.

This soil is found at elevations around 5500 feet and associated with the *Artemisia tridentata/Bromus tectorum* community. It is found on a wet facing fan with three to six percent slope. Stoniness class is 0 and the majority of the roots are found within 28 inches of the surface. There is slight to no erosion.

A11	0 - 2 1/2"	Light gray (10YR 7/2) loamy sand, dark brown (10YR 3/3) moist; massive, weakly coherent, very friable, nonsticky, nonplastic; few very fine roots; few very fine vesicular pores; noneffervescent; neutral (pH 6.6); abrupt smooth boundary.
A12	2 1/2 - 10"	Light brownish gray (10YR 3/3) moist; weak medium subangular blocky; weakly coherent; very friable; nonsticky, nonplastic; few very fine and fine roots; noneffervescent; neutral (pH 6.8); clear smooth boundary.
B2	10 - 26"	Pale brown (10YR 6/3) heavy sandy loam, dark, yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; few medium and few very fine roots; noneffervescent; neutral (pH 6.9); graduat smooth boundary.

C1	26 - 33"+	Pale brown (10YR 6/3) sandy loam, dark yellowish brown (10YR 4/4) moist; massive; weakly coherent, very friable, nonsticky, nonplastic; noneffervescent; mildly alkaline (pH 7.4).

UPPER SITE:

This soil is classified as a very fine, mixed, frigid family of Xerollic Durargids. It has a four inch ochric epipedon over a massive argillic horizon. Reaction of the solum increases with depth and ranges from neutral to strongly alkaline.

The soil is found at elevations around 6500 feet and is associated with the *Artemisia tridentata/Bromus tectorum* community. It is found on a west facing rolling upper bench with 10 - 22 percent slope. The soil belongs to the D hydrologic group. Stoniness class is 2 and the majority of the roots are found within 14 inches of the surface. There is slight to no erosion.

A1	0 - 4"	Light yellowish brown (10YR 6/4) fine sandy loam, dark brown (10YR 3/3) moist; massive, weakly coherent, very friable, nonsticky, nonplastic; plentiful very fine roots; vesicular pores; strongly effervescent; neutral (pH 6.6); abrupt smooth boundary.
B21t	4 - 10"	Dark yellowish brown (10YR 3/4) moist; clay; strong medium subangular blocky; hard, firm, very sticky, very plastic; clay films; few medium and plentiful very fine roots; non-effervescent; moderately alkaline (pH 8.4); clear smooth boundary.
B22t	10 - 17"	Dark brown (7.5YR 4/4) moist; clay; massive; hard, firm, very sticky, very plastic; clay films; few medium and plentiful very fine roots; slightly effervescent; strongly alkaline (pH 8.6); clear smooth boundary.

B3	17 - 22"	Yellow (10YR 7/6) light clay, yellowish brown (10YR 5/8) moist; massive; hard, friable, very sticky, very plastic; few medium and very fine roots; violently effervescent; strongly alkaline (pH 8.6); abrupt smooth boundary.
Ccasim	22 - 25"+	Indurated duripan.

Gifford (1968a) described the soils at the two sites. His descriptions are presented below and are separated by site.

UPPER SITE:

A	0 - 7"	Dark brown (10YR 3/3) moist, brown (10YR 5/3) dry, friable loam (37 percent sand, 43 percent silt) with crumb structure; non-calcareous; 0.7 percent organic matter; gravelly pH 6.8 to 7.2; average 27 percent rock (>2mmd); average percent moisture at wilting point at 6 inch depth, 26.77 percent by weight; average percent moisture at field capacity at 6 inch depth, 45.23 percent by weight; boundary fairly distinct, 4 to 7 inches thick.
B	7 - 18"	Dark reddish brown (5YR 3/3) moist, reddish brown (5YR 4/3) dry, clay loam (32 percent sand, and 31 percent silt) with medium subangular blocky structure; non-calcareous; 0.8 to 0.9 percent organic matter; gravelly; pH 7.1; average percent moisture at wilting point, 24.34 percent by weight; average percent moisture at field capacity, 46.24 percent by weight; boundary fairly distinct; 8 to 12 inches thick.
C	18"	calcareous; cemented gravelly material, some granite boulders present.

LOWER SITE:

	0 - 6"	Very dark grayish brown (10YR 3/2) moist, brown (10YR 5/3) dry, friable sandy loam (56 percent sand, 32 percent silt) with generally massive structure; non-calcareous; 0.36 percent organic matter; gravelly with some boulders present; bulk density (gms/cc) 1.58; pH 7.0; 20-45 percent rock (>2mmd); average percent moisture at wilting point, 5.50 percent by weight; average percent moisture at field capacity, 13.15 percent by weight.

12" Dark brown (10YR 3/3) moist, grayish brown (10YR 5/2) dry, sandy loam (63 percent sand, 24 percent silt) with massive structure; non-calcareous; 0.4 percent organic matter; gravelly with some boulders present; pH 7.3; other characteristics similar to above.

24" Very dark grayish brown (10YR 3/2) moist, light brownish gray (10YR 6/2) dry, sandy loam with massive structure; non-calcareous; pH 8.4; other characteristics similar to above.

36" Dark brown (10YR 3/3) moist, light brownish gray (10YR 6/2) dry, sandy loam with massive structure; calcareous; pH 8.5; other characteristics similar to above.

APPENDIX B

Tables 36 through 39

1966 and 1968 Dependent Variables

Table 36.--Summary of dependent variables[a/] by treatment and condition for 1966 lower site tests.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	SUSP SED
01	D	01	>3.70	>3.70	>3.70	3.20	2.23	2.23	1.56	0.02
01	W	01	>3.70	3.15	2.50	2.00	1.55	1.31	1.38	0.35
32	D	01	>3.70	>3.70	2.83	2.83	2.83	2.83	1.54	0.05
32	W	01	>3.70	3.45	2.90	2.83	2.83	2.83	1.58	0.12
42	D	01	>3.70	>3.70	>3.70	>3.70	3.45	3.25	1.73	0.00
42	W	01	>3.70	3.65	2.55	2.41	2.41	2.41	1.51	0.25
46	D	01	>3.70	>3.70	>3.70	>3.70	>3.70	3.60	1.79	0.00
46	W	01	>3.70	>3.70	>3.70	2.84	2.84	2.84	1.58	0.22
05	D	02	>3.70	1.60	1.40	1.37	1.35	1.32	1.15	1.18
05	W	02	2.70	1.83	1.40	1.32	1.32	1.32	1.10	1.48
16	D	02	>3.70	2.70	1.85	1.75	1.42	1.42	1.35	0.91
16	W	02	1.55	1.31	1.31	1.31	1.31	1.31	1.08	1.50
25	D	02	>3.70	2.20	1.70	1.53	1.53	1.53	1.02	3.95
25	W	02	2.00	0.70	0.35	0.27	0.27	0.27	0.56	4.73
29	D	02	>3.70	>3.70	3.60	3.20	2.60	2.59	1.64	0.00
29	W	02	>3.70	2.80	2.00	1.77	1.70	1.68	1.36	0.08
07	D	03	>3.70	>3.70	>3.70	>3.70	>3.70	>3.70	1.85	0.00
07	W	03	>3.70	3.40	3.22	3.18	3.14	3.14	1.60	0.09
10	D	03	>3.70	3.45	2.95	2.60	2.50	2.50	1.37	0.20
10	W	03	2.50	2.10	2.00	1.50	1.43	1.43	1.18	0.78
23	D	03	>3.70	>3.70	2.35	2.10	2.04	2.04	1.36	1.01
23	W	03	3.65	1.10	1.03	1.03	1.03	1.03	0.92	2.82
47	D	03	>3.70	>3.70	>3.70	3.10	2.70	2.12	1.59	0.00
47	W	03	>3.70	2.55	1.75	1.70	1.60	1.52	1.27	0.44

Table 36.--Continued.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	SUSP SED
26	D	04	>3.70	>3.70	3.23	2.81	2.81	2.81	1.48	0.03
26	W	04	3.25	1.70	1.62	1.62	1.62	1.62	1.09	2.11
02	D	04	>3.70	3.55	2.95	2.55	2.25	2.11	1.45	0.09
02	W	04	>3.70	3.33	2.85	1.96	1.96	1.96	1.43	0.30
17	D	04	>3.70	>3.70	>3.70	2.78	2.50	2.45	1.82	0.00
17	W	04	>3.70	>3.70	>3.70	>3.70	2.90	2.69	1.72	0.00
44	D	04	>3.70	2.30	2.00	1.90	1.75	1.60	1.43	0.34
44	W	04	2.05	1.60	1.35	1.32	1.32	1.32	1.04	1.58
04	D	05	>3.70	3.61	3.10	2.95	2.85	2.64	1.54	0.19
04	W	05	>3.70	2.50	2.11	2.11	2.11	2.11	1.33	0.78
18	D	05	>3.70	>3.70	>3.70	>3.70	>3.70	>3.70	1.85	0.00
18	W	05	>3.70	>3.70	>3.70	3.62	3.60	3.60	1.75	0.00
31	D	05	>3.70	3.45	3.30	3.25	3.22	3.22	1.64	0.00
31	W	05	>3.70	>3.70	>3.70	3.65	3.58	3.55	1.68	0.08
43	D	05	>3.70	3.65	3.03	2.90	2.60	2.57	1.76	0.00
43	W	05	3.50	3.00	2.60	2.38	2.38	2.38	1.45	0.13
08	D	06	>3.70	>3.70	>3.70	2.68	2.64	2.64	1.57	0.13
08	W	06	2.40	1.95	1.65	1.60	1.60	1.60	1.13	0.80
22	D	06	>3.70	>3.70	2.15	1.79	1.79	1.79	1.32	0.84
22	W	06	2.05	1.18	1.18	1.18	1.18	1.18	0.88	1.47
27	D	06	>3.70	3.00	2.71	2.71	2.71	2.71	1.35	0.77
27	W	06	1.95	1.20	0.95	0.95	0.95	0.95	0.87	2.46
45	D	06	>3.70	>3.70	>3.70	3.65	3.58	3.27	1.77	0.00
45	W	06	3.50	2.20	2.00	2.00	2.00	2.00	1.23	0.37

a/ Infiltration rates for 5, 10, 15, 20, 25, and 30 minute periods are shown as I5, I10, etc. Units are in inches per hour. INR value is total inches of water retained on plot. Sediment values are in tons per acre.

Table 37.--Summary of dependent variables[a/] by treatment and condition for 1966 upper site tests.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	SUSP SED
12	D	01	>3.70	2.50	1.70	1.45	1.42	1.42	1.26	0.56
12	W	01	2.25	1.63	1.30	1.16	1.13	1.13	1.06	1.21
39	D	01	3.65	1.75	1.25	1.02	1.02	1.02	1.24	1.95
39	W	01	1.25	1.02	1.02	1.02	1.02	1.02	0.87	2.91
31	D	01	>3.70	3.65	3.55	3.20	2.70	2.70	1.62	0.20
31	W	01	2.40	1.80	1.60	1.60	1.60	1.60	1.22	1.02
21	D	01	3.65	2.70	1.90	1.90	1.90	1.90	1.28	1.19
21	W	01	1.90	1.55	1.47	1.47	1.47	1.47	0.98	2.03
04	D	02	>3.70	>3.70	>3.70	3.20	2.87	2.66	1.65	0.21
04	W	02	3.10	1.57	1.45	1.10	0.95	0.95	1.04	2.00
08	D	02	>3.70	3.52	2.20	1.62	1.62	1.62	1.34	0.28
08	W	02	1.35	1.10	0.95	0.90	0.90	0.90	0.90	1.31
36	D	02	3.67	1.80	1.40	1.36	1.36	1.36	1.19	1.02
36	W	02	2.10	1.30	1.04	0.95	0.94	0.94	1.00	0.95
46	D	02	3.68	3.63	0.76	0.76	0.76	0.76	1.12	1.83
46	W	02	0.98	0.89	0.89	0.89	0.89	0.89	0.91	1.69
34	D	03	>3.70	3.63	3.25	2.90	2.62	2.23	1.57	0.31
34	W	03	2.90	2.15	2.15	2.05	2.00	2.00	1.22	0.72
20	D	03	3.69	3.25	2.72	2.00	1.73	1.31	1.42	0.53
20	W	03	2.40	1.80	1.75	1.75	1.75	1.75	1.17	0.81
03	D	03	3.68	2.75	1.80	1.22	0.83	0.82	1.29	0.27
03	W	03	1.85	1.25	0.85	0.50	0.27	0.27	0.81	1.15
26	D	03	>3.70	1.97	1.75	1.50	1.43	1.43	1.27	0.25
26	W	03	2.00	1.48	1.43	1.43	1.43	1.43	1.22	0.76

Table 37.--Continued.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	SUSP SED
15	D	04	>3.70	>3.70	3.18	2.10	2.07	2.07	1.50	0.13
15	W	04	2.60	1.53	1.53	1.53	1.53	1.53	1.17	0.23
09	D	04	>3.70	2.60	1.75	1.70	1.66	1.66	1.33	0.67
09	W	04	1.35	1.00	0.88	0.86	0.84	0.82	0.95	2.41
42	D	04	>3.70	3.68	3.60	3.53	3.30	2.62	1.66	0.00
42	W	04	3.60	2.82	2.18	2.08	2.08	2.08	1.38	0.18
33	D	04	>3.70	3.64	3.50	3.22	3.13	3.13	1.67	0.18
33	W	04	3.40	2.33	2.15	1.79	1.79	1.79	1.38	1.03
32	D	05	>3.70	3.68	3.65	3.37	3.17	2.84	1.66	0.01
32	W	05	3.57	2.45	2.41	2.41	2.41	2.41	1.38	0.37
01	D	05	>3.70	2.60	1.93	1.87	1.80	1.64	1.32	0.10
01	W	05	2.15	1.33	1.27	1.27	1.27	1.27	0.98	0.63
48	D	05	>3.70	3.15	2.33	2.10	1.22	1.22	1.43	0.18
48	W	05	1.50	1.25	1.13	1.03	1.03	1.03	0.96	0.73
10	D	05	>3.70	2.45	2.14	2.14	2.14	2.14	1.40	0.15
10	W	05	2.25	1.75	1.66	1.66	1.66	1.66	1.19	0.21
38	D	06	2.50	1.47	1.47	1.47	1.47	1.47	1.15	3.05
38	W	06	1.15	1.07	1.07	1.07	1.07	1.07	0.79	4.04
06	D	06	>3.70	2.50	1.40	1.33	1.33	1.33	1.29	1.20
06	W	06	1.30	0.99	0.99	0.99	0.99	0.99	0.77	3.08
30	D	06	3.65	3.05	2.18	1.35	0.83	0.65	1.31	1.26
30	W	06	1.20	0.65	0.65	0.65	0.65	0.65	0.80	2.03
18	D	06	>3.70	2.45	1.55	1.25	1.25	1.25	1.20	1.76
18	W	06	1.05	0.76	0.76	0.76	0.76	0.76	0.81	5.07

a/ Infiltration rates for 5,10, 15, 20, 25, and 30 minute periods are shown as I5, I10, etc. Units are in inches per hour. INR value is total inches of water retained on plot. Sediment values are in tons per acre.

Table 38.--Summary of dependent variables[a] by treatment and condition for 1968 lower site tests.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	TOT SED	SUSP SED
01	D	01	3.58	3.34	3.10	2.88	2.71	2.57	1.21	1.03	0.47
01	W	01	3.19	2.78	2.30	1.98	1.77	1.63	0.72	1.55	0.89
32	D	01	3.54	3.33	3.15	2.92	2.73	2.60	1.21	2.36	1.43
32	W	01	3.48	3.25	2.94	2.68	2.49	2.31	1.07	2.42	1.64
42	D	01	3.65	3.46	3.42	3.35	3.26	3.17	1.52	0.53	0.05
42	W	01	3.30	2.74	2.42	2.21	2.08	1.98	0.92	2.35	1.26
46	D	01	3.64	3.56	3.49	3.46	3.42	3.39	1.64	1.14	0.33
46	W	01	3.44	3.34	3.29	3.21	3.08	2.95	1.39	1.71	1.19
05	D	02	3.41	3.00	2.66	2.43	2.24	2.10	0.98	2.59	2.00
05	W	02	2.88	2.22	1.88	1.68	1.51	1.44	0.64	3.08	2.68
16	D	02	3.48	3.19	2.80	2.55	2.35	2.20	1.01	3.87	2.85
16	W	02	3.16	2.46	2.03	1.75	1.56	1.42	0.61	4.41	3.47
25	D	02	3.44	3.01	2.46	2.13	1.86	1.86	0.82	6.69	5.67
25	W	02	3.08	2.11	1.54	1.21	1.02	0.86	0.32	4.69	4.34
29	D	02	3.60	3.37	3.21	3.14	3.09	3.07	1.47	0.91	0.52
29	W	02	3.22	2.67	2.38	2.20	2.08	2.00	0.90	2.37	1.65
07	D	03	3.63	3.34	3.21	3.15	3.08	3.04	1.46	0.19	0.07
07	W	03	3.52	3.24	3.05	2.93	2.85	2.79	1.33	0.19	0.05
10	D	03	3.56	3.43	3.18	2.96	2.79	2.64	1.25	0.94	0.67
10	W	03	3.31	2.82	2.35	2.17	2.04	1.93	0.89	1.05	0.96
23	D	03	3.62	3.38	2.81	2.46	2.24	2.07	0.96	2.69	2.51
23	W	03	3.41	2.70	2.13	1.75	1.51	1.36	0.60	3.59	3.49
47	D	03	3.64	3.59	3.56	3.53	3.49	3.44	1.66	0.36	0.06
47	W	03	3.57	3.41	3.20	3.02	2.89	2.78	1.29	1.07	0.07

Table 38.--Continued.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	TOT SED	SUSP SED
02	D	04	3.52	3.29	3.15	3.06	2.99	2.94	1.41	1.36	1.05
02	W	04	3.08	2.64	2.33	2.17	2.07	1.95	0.90	2.17	0.67
17	D	04	3.62	3.41	3.24	3.14	3.08	3.01	1.44	0.98	0.19
17	W	04	3.33	2.84	2.54	2.34	2.21	2.10	0.96	2.64	1.90
26	D	04	3.65	3.57	3.42	3.27	3.15	3.05	1.46	1.87	1.61
26	W	04	3.45	3.06	2.71	2.50	2.34	2.23	1.04	3.04	2.30
44	D	04	3.66	3.61	3.57	3.46	3.34	3.22	1.54	1.09	0.96
44	W	04	3.55	3.24	2.93	2.75	2.63	2.55	1.19	1.22	1.12
04	D	05	3.51	3.21	2.93	2.71	2.54	2.44	1.13	1.32	1.03
04	W	05	3.32	2.80	2.48	2.28	2.17	2.08	0.96	1.09	0.93
18	D	05	3.63	3.49	3.44	3.41	3.39	3.38	1.63	0.31	0.01
18	W	05	3.49	3.37	3.32	3.30	3.27	3.24	1.56	0.49	0.01
31	D	05	3.59	3.48	3.38	3.31	3.21	3.12	1.50	0.51	0.20
31	W	05	3.44	3.04	2.75	2.55	2.40	2.28	1.06	1.06	0.66
43	D	05	3.66	3.61	3.57	3.52	3.47	3.41	1.65	0.38	0.04
43	W	05	3.63	3.41	3.27	3.15	3.03	2.91	1.39	0.47	0.08
08	D	06	3.55	3.21	2.95	2.73	2.58	2.44	1.15	1.15	0.53
08	W	06	2.99	2.30	1.96	1.76	1.65	1.55	0.70	8.87	7.99
22	D	06	3.55	2.79	2.28	1.95	1.74	1.59	0.70	1.81	1.46
22	W	06	2.52	1.84	1.45	1.23	1.10	0.98	0.40	2.01	1.66
27	D	06	3.40	2.80	2.42	2.18	2.02	1.89	0.86	6.84	6.56
27	W	06	2.99	2.21	1.77	1.50	1.30	1.16	0.49	3.27	2.22
45	D	06	3.68	3.62	3.59	3.57	3.54	3.48	1.68	0.44	0.06
45	W	06	3.49	3.16	2.88	2.69	2.56	2.46	1.14	1.15	0.56

Table 38.--Continued.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	TOT SED	SUSP SED
12	D	07	3.58	3.14	2.52	2.12	1.89	1.71	0.77	1.62	1.11
12	W	07	3.02	2.39	1.96	1.66	1.47	1.33	0.58	2.35	1.85
19	D	07	3.67	3.53	3.41	3.30	3.09	2.94	1.40	0.37	0.14
19	W	07	3.52	3.13	2.73	2.50	2.31	2.17	1.01	0.49	0.22
21	D	07	3.68	3.55	3.47	3.34	3.09	2.90	1.37	1.02	0.37
21	W	07	3.33	2.79	2.19	1.80	1.55	1.36	0.58	1.93	1.07
36	D	07	3.54	3.24	2.75	2.44	2.20	1.98	0.89	1.06	0.64
36	W	07	3.31	2.90	2.50	2.13	1.89	1.73	0.76	0.84	0.41
09	D	08	3.65	3.56	3.36	3.07	2.80	2.61	1.21	1.27	0.60
09	W	08	3.52	3.18	2.56	2.11	1.82	1.61	0.70	1.49	0.88
24	D	08	3.64	3.49	3.28	2.07	2.88	2.73	1.28	0.61	0.22
24	W	08	3.42	2.88	2.32	1.99	1.76	1.61	0.70	1.28	0.46
30	D	08	3.59	3.47	3.33	3.16	3.03	2.90	1.38	0.86	0.20
30	W	08	3.46	2.92	2.52	2.28	2.13	2.02	0.92	1.19	0.17
41	D	08	3.56	3.40	3.33	3.24	3.02	2.83	1.34	1.11	0.32
41	W	08	3.37	2.71	2.20	1.87	1.66	1.52	0.66	1.46	0.60
11	D	09	3.55	3.08	2.36	1.78	1.43	1.21	0.49	3.01	2.75
11	W	09	2.75	1.77	1.17	0.85	0.65	0.50	0.13	4.19	3.97
13	D	09	3.65	3.06	2.41	1.90	1.56	1.35	0.55	1.36	1.06
13	W	09	3.45	2.24	1.59	1.25	1.01	0.86	0.31	1.56	1.28
35	D	09	3.60	2.41	1.78	1.45	1.21	1.04	0.41	1.21	1.12
35	W	09	3.01	1.76	1.25	0.97	0.79	0.67	0.23	1.61	1.35
40	D	09	3.63	3.44	3.27	3.01	2.66	2.34	1.08	1.11	0.53
40	W	09	3.18	2.44	1.76	1.42	1.22	1.07	0.43	1.96	1.43

Table 38.--Continued.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	TOT SED	SUSP SED
03	D	10	3.56	3.37	3.24	2.60	2.12	1.83	0.78	1.47	1.02
03	W	10	3.25	2.51	1.72	1.28	1.05	0.89	0.29	1.41	1.00
14	D	10	3.13	2.29	1.61	1.25	1.01	0.84	0.31	2.85	2.08
14	W	10	2.45	1.45	0.93	0.63	0.46	0.36	0.05	2.93	2.11
38	D	10	3.55	2.92	2.17	1.67	1.42	1.24	0.53	2.10	1.53
38	W	10	2.15	1.37	0.93	0.69	0.52	0.41	0.11	2.65	1.83
48	D	10	3.65	3.59	3.51	3.46	3.43	3.28	1.57	1.37	0.14
48	W	10	3.55	3.43	3.25	2.90	2.66	2.41	1.10	0.79	0.27
06	D	11	3.58	3.36	3.22	3.10	2.97	2.82	1.32	0.68	0.54
06	W	11	3.39	3.10	2.78	2.40	2.19	2.01	0.88	0.89	0.69
20	D	11	3.64	3.51	3.31	3.16	3.03	2.80	1.31	1.02	0.98
20	W	11	3.40	2.89	2.35	1.96	1.75	1.61	0.71	2.23	2.17
33	D	11	3.56	3.15	2.89	2.67	2.10	1.56	0.66	1.90	1.40
33	W	11	3.33	2.95	2.41	1.93	1.55	1.27	0.51	8.67	1.03
39	D	11	3.53	3.25	2.76	2.29	2.00	1.80	0.81	1.75	1.08
39	W	11	3.06	1.97	1.40	1.06	0.85	0.72	0.25	3.14	2.55
15	D	12	3.50	2.98	2.47	2.12	1.87	1.70	0.77	1.75	1.08
15	W	12	3.09	2.15	1.69	1.45	1.27	1.20	0.50	1.77	0.99
28	D	12	3.58	3.13	2.82	2.58	2.41	2.27	1.06	2.53	2.09
28	W	12	3.18	2.47	2.05	1.78	1.60	1.48	0.65	3.12	2.02
34	D	12	3.56	3.33	2.93	2.57	2.28	2.08	0.95	2.35	2.17
34	W	12	3.17	2.41	1.94	1.69	1.51	1.39	0.58	2.12	1.44
37	D	12	3.56	2.98	2.50	2.16	1.89	1.70	0.76	1.93	1.01
37	W	12	2.72	2.07	1.71	1.50	1.36	1.28	0.52	1.03	0.51

a/ Infiltration rates for 5, 10, 15 20, 25, and 30 minute periods are shown as I5, I10, etc. Units are in inches per hour. INR value is total inches of water retained on plot. Sediment values are in tons per acre.

Table 39.--Summary of dependent variables[a] by treatment and condition for 1968 upper site tests.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	TOT SED	SUSP SED
12	D	01	3.57	3.54	3.49	3.46	3.42	3.38	1.75	0.15	0.15
12	W	01	3.52	3.17	2.94	2.75	2.57	2.44	1.26	0.35	0.35
21	D	01	3.61	3.58	3.50	3.32	3.16	3.01	1.56	0.45	0.39
21	W	01	3.33	2.76	2.45	2.28	2.17	2.10	1.09	0.66	0.60
31	D	01	3.59	3.53	3.47	3.39	3.34	3.27	1.70	0.36	0.27
31	W	01	3.32	3.07	2.89	2.77	2.69	2.62	1.36	0.49	0.40
39	D	01	3.56	3.38	3.03	2.74	2.52	2.36	1.22	1.06	0.88
39	W	01	2.94	2.24	1.87	1.65	1.49	1.38	0.72	1.30	1.27
04	D	02	3.59	3.58	3.57	3.56	3.56	3.55	1.85	0.09	0.02
04	W	02	3.55	3.52	3.49	3.45	3.42	3.40	1.76	0.14	0.07
08	D	02	3.60	3.59	3.59	3.58	3.57	3.57	1.85	0.07	0.01
08	W	02	3.57	3.32	2.98	2.80	2.68	2.58	1.34	0.31	0.25
36	D	02	3.54	3.47	3.41	3.30	3.18	3.09	1.60	0.52	0.51
36	W	02	3.43	3.33	3.15	2.97	2.85	2.76	1.42	0.55	0.55
46	D	02	3.60	3.55	3.53	3.50	3.47	3.41	1.77	0.22	0.21
46	W	02	3.37	3.02	2.65	2.41	2.24	2.11	1.09	0.93	0.92
03	D	03	3.56	3.51	3.39	3.24	3.09	2.96	1.53	0.53	0.40
03	W	03	3.33	2.82	2.47	2.27	2.14	2.03	1.05	0.83	0.67
20	D	03	3.60	3.57	3.51	3.44	3.36	3.27	1.70	0.29	0.18
20	W	03	3.12	2.82	2.60	2.42	2.29	2.19	1.14	0.73	0.57
26	D	03	3.61	3.58	3.55	3.52	3.47	3.41	1.77	0.28	0.25
26	W	03	3.37	2.96	2.68	2.50	2.40	2.31	1.20	1.18	1.17
34	D	03	3.55	3.46	3.36	3.21	3.07	2.95	1.53	0.75	0.72
34	W	03	3.37	2.89	2.58	2.38	2.22	2.10	1.09	0.99	0.96

Table 39.--Continued.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	TOT SED	SUSP SED
09	D	04	3.59	3.47	3.36	3.26	3.16	3.06	1.59	0.67	0.50
09	W	04	3.03	2.73	2.50	2.35	2.24	2.18	1.14	1.49	1.17
15	D	04	3.59	3.58	3.57	3.55	3.53	3.52	1.83	0.10	0.03
15	W	04	3.55	3.50	3.38	3.31	3.26	3.22	1.67	0.16	0.13
33	D	04	3.59	3.57	3.55	3.52	3.50	3.48	1.81	0.24	0.09
33	W	04	3.49	3.40	3.32	3.27	3.23	3.20	1.67	0.39	0.38
42	D	04	3.60	3.54	3.49	3.42	3.36	3.30	1.71	0.24	0.21
42	W	04	3.51	3.44	3.30	3.17	3.09	3.02	1.57	0.28	0.24
01	D	05	3.59	3.52	3.41	3.29	3.19	3.10	1.61	0.30	0.14
01	W	05	3.40	2.87	2.52	2.30	2.17	2.09	0.08	0.38	0.22
10	D	05	3.61	3.55	3.47	3.38	3.31	3.24	1.68	0.23	0.21
10	W	05	3.51	3.30	3.09	2.96	2.87	2.81	1.46	0.33	0.32
32	D	05	3.60	3.51	3.40	3.31	3.25	3.20	1.66	0.64	0.55
32	W	05	3.38	3.17	3.04	2.94	2.86	2.81	1.45	0.63	0.63
48	D	05	3.62	3.58	3.52	3.42	3.28	3.14	1.63	0.68	0.64
48	W	05	3.38	2.91	2.62	2.43	2.30	2.21	1.15	0.97	0.93
06	D	06	3.59	3.56	3.51	3.45	3.35	3.23	1.67	0.54	0.46
06	W	06	3.42	2.95	2.56	2.33	2.18	2.08	1.08	1.05	1.00
18	D	06	3.60	3.55	3.49	3.34	3.17	3.00	1.55	0.79	0.53
18	W	06	2.96	2.32	2.02	1.83	1.70	1.61	0.83	1.51	0.94
30	D	06	3.58	3.53	3.47	3.47	3.39	3.32	1.73	0.36	0.31
30	W	06	3.40	3.16	2.93	2.76	2.62	2.50	1.30	0.72	0.71
38	D	06	3.56	3.54	3.45	3.32	3.21	3.10	1.60	0.11	0.11
38	W	06	3.52	3.23	2.95	2.79	2.68	2.60	1.34	0.13	0.12

Table 39.--Continued.

Plot	Cond.	Trt,	I5	I10	I15	I20	I25	I30	INR	TOT SED	SUSP SED
05	D	07	3.60	3.39	2.90	2.61	2.43	2.29	1.18	0.76	0.69
05	W	07	2.76	2.12	1.85	1.65	1.49	1.39	0.71	1.07	0.80
13	D	07	3.55	2.97	2.50	2.16	1.94	1.78	0.92	2.44	2.27
13	W	07	2.81	2.13	1.85	1.57	1.36	1.18	0.62	3.29	2.67
27	D	07	3.58	3.30	3.14	2.99	2.79	2.59	1.34	0.80	0.59
27	W	07	3.42	2.76	2.29	1.98	1.80	1.66	0.86	1.33	1.14
43	D	07	3.61	3.16	2.75	2.48	2.27	2.10	1.09	1.73	1.65
43	W	07	2.35	1.62	1.31	1.12	0.99	0.90	0.48	4.04	3.96
16	D	08	3.54	3.15	2.93	2.79	2.67	2.58	1.35	1.67	1.31
16	W	08	2.94	2.53	2.33	2.17	2.05	1.96	1.02	2.57	2.15
19	D	08	3.58	3.53	3.27	2.90	2.58	2.34	1.20	1.10	0.96
19	W	08	3.28	2.16	1.81	1.64	1.52	1.42	0.73	1.31	1.18
25	D	08	3.59	3.36	2.80	2.33	2.07	1.90	0.98	1.31	1.23
25	W	08	3.41	2.47	1.98	1.73	1.66	1.60	0.83	1.77	1.69
47	D	08	3.53	2.70	2.11	1.78	1.56	1.39	0.73	3.68	3.49
47	W	08	2.59	1.56	1.14	0.93	0.78	0.67	0.37	4.92	4.69
11	D	09	3.46	2.89	2.24	1.79	1.47	1.26	0.66	2.70	2.60
11	W	09	2.66	1.67	1.22	0.97	0.82	0.68	0.36	2.69	2.66
17	D	09	3.56	3.50	3.17	2.81	2.54	2.33	1.21	0.97	0.96
17	W	09	2.77	1.92	1.46	1.19	1.01	0.88	0.46	1.37	1.36
35	D	09	3.52	3.32	2.98	2.45	2.13	1.93	1.00	1.36	1.30
35	W	09	3.04	2.12	1.68	1.41	1.23	1.10	0.58	1.58	1.52
44	D	09	3.62	3.58	3.56	3.36	3.05	2.80	1.44	0.54	0.52
44	W	09	3.31	2.26	1.74	1.46	1.28	1.15	0.60	1.33	1.32

Table 39.--Continued.

Plot	Cond.	Trt.	I5	I10	I15	I20	I25	I30	INR	TOT SED	SUSP SED
22	D	10	3.58	3.50	3.43	3.17	2.85	2.60	1.34	0.95	0.93
22	W	10	3.31	2.42	2.05	1.82	1.65	1.55	0.81	1.51	1.47
24	D	10	3.60	3.57	3.43	3.29	3.18	3.08	1.60	0.49	0.45
24	W	10	3.27	2.89	2.57	2.32	2.17	2.07	1.07	2.02	1.87
29	D	10	3.61	3.50	3.10	2.79	2.55	2.34	1.21	1.33	1.26
29	W	10	3.29	2.40	1.93	1.67	1.50	1.38	0.72	1.42	1.33
41	D	10	3.42	2.45	1.87	1.49	1.28	1.12	0.60	6.52	6.09
41	W	10	2.31	1.39	1.01	0.81	0.65	0.54	0.31	5.75	5.32
02	D	11	3.49	3.34	3.01	2.58	2.28	2.06	1.05	1.07	0.62
02	W	11	3.41	2.49	2.02	1.74	1.55	1.43	0.73	0.82	0.57
23	D	11	3.58	3.54	3.37	3.17	2.98	2.84	1.46	1.35	0.95
23	W	11	3.16	2.60	1.98	1.59	1.42	1.32	0.68	3.69	3.06
28	D	11	3.52	3.02	2.15	1.63	1.23	1.02	0.53	4.08	3.90
28	W	11	3.27	2.06	1.63	1.36	1.19	1.09	0.57	3.55	3.51
40	D	11	3.54	3.46	3.41	3.35	3.28	3.16	1.62	0.69	0.67
40	W	11	3.51	3.35	2.72	2.24	1.94	1.72	0.87	1.84	1.82
07	D	12	3.59	3.56	3.47	3.24	3.02	2.84	1.47	0.83	0.82
07	W	12	2.90	2.18	1.84	1.64	1.52	1.44	0.75	1.42	1.39
14	D	12	3.59	3.49	3.36	3.26	3.16	3.05	1.58	1.35	1.27
14	W	12	3.01	2.53	2.12	1.87	1.70	1.60	0.83	2.21	2.14
37	D	12	3.59	3.55	3.52	3.45	3.36	3.27	1.69	0.73	0.64
37	W	12	3.46	3.00	2.56	2.28	2.12	2.00	1.04	2.09	1.99
45	D	12	3.58	3.52	3.47	3.39	3.31	3.20	1.66	0.80	0.79
45	W	12	2.86	2.16	1.83	1.63	1.50	1.41	0.74	3.42	3.38

a/ Infiltration rates for 5, 10, 15, 20, 25, and 30 minute periods are shown as I5, I10, etc. Units are in inches per hour. INR value is total inches of water retained on plot. Sediment values are in tons per acre.

APPENDIX C

Tables 40 through 55

Analyses of Variance on Selected

1968 Independent Variables

Table 40.--Lower site mean percent live shrub canopy cover (X23) in September 1968.

Treatment No.	Code	Shrub Cover	
03	C1	20.1	a
12	C2	18.4	ab
01	RD1	9.9	bc
07	RD2	9.0	c
04	SMD1	3.7	c
09	PD2	3.4	c
10	PMD2	3.2	c
05	SD1	3.1	c
02	PMD1	2.6	c
08	SD2	2.4	c
06	PD1	2.3	c
11	SMD2	1.6	c

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 41.--Upper site mean percent live shrub canopy cover (X23) in September 1968.

Treatment No.	Treatment Code	Shrub Cover	
03	C1	9.4	a
12	C2	8.5	ab
01	RD1	7.3	ab
05	SD1	2.6	bc
02	PMD1	0.5	c
04	SMD1	0.5	c
07	RD2	0.0	c
08	SD2	0.0	c
09	PD2	0.0	c
10	PMD2	0.0	c
11	SMD2	0.0	c
06	PD1	0.0	c

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 42.--Lower site mean percent perennial grass canopy cover (X26) in September 1968.

Treatment No.	Treatment Code	Perennial Grass Cover
08	SD2	2.5
11	SMD2	2.4
09	PD2	2.0
07	RD2	1.8
01	RD1	1.3
05	SD1	0.8
12	C2	0.7
02	PMD1	0.6
04	SMD1	0.6
10	PMD2	0.5
06	PD1	0.4
03	C1	0.1

Above values are not significantly different at the 5-percent probability level.

Table 43.--Upper site mean percent perennial grass canopy cover (X26) in September 1968.

Treatment No.	Treatment Code	Perennial Grass Cover	
05	SD1	10.5	a
04	SMD1	7.9	ab
06	PD1	4.6	bc
03	C1	3.4	cd
12	C2	3.3	cd
01	RD1	3.2	cd
02	PMD1	2.1	cd
10	PMD2	1.8	cd
08	SD2	1.0	cd
11	SMD2	0.8	cd
09	PD2	0.5	d
07	RD2	0.2	d

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 44.--Lower site mean percent total grass canopy cover (X27) in September 1968.

Treatment No.	Treatment Code	Total Grass Cover	
07	RD2	3.3	a
08	SD2	2.5	ab
11	SMD2	2.4	ab
09	PD2	2.1	abc
01	RD1	1.6	abc
05	SD1	1.1	abc
10	PMD2	0.7	bc
02	PMD1	0.7	bc
12	C2	0.7	bc
04	SMD1	0.6	bc
06	PD1	0.4	bc
03	C1	0.1	c

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 45.--Upper site mean percent total grass canopy cover (X27) in September 1968.

Treatment No.	Treatment Code	Total Grass Cover	
02	PMD1	47.9	a
04	SMD1	45.6	a
06	PD1	45.6	a
05	SD1	44.3	ab
09	PD2	29.7	bc
01	RD1	24.1	cd
03	C1	21.4	cd
07	RD2	20.1	cd
10	PMD2	20.0	cd
12	C2	14.2	cd
11	SMD2	9.0	d
08	SD2	8.4	d

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 46.--Lower site mean percent total cover (X35) in September 1968.

Treatment No.	Treatment Code	Percent Total Cover	
01	RD1	76.7	a
05	SD1	68.5	ab
03	C1	67.6	ab
08	SD2	57.6	abc
02	PMD1	57.5	abc
04	SMD1	53.6	bc
07	RD2	53.2	bc
12	C2	52.3	bc
06	PD1	51.6	bc
09	PD2	46.1	c
11	SMD2	44.5	c
10	PMD2	40.6	c

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 47.--Upper site mean percent total cover (X35) in September 1968.

Treatment No.	Treatment Code	Percent Total Cover	
05	SD1	139.2	a
02	PMD1	133.0	ab
04	SMD1	132.0	ab
06	PD1	128.4	ab
01	RD1	110.5	bc
03	C1	109.5	bc
12	C2	90.0	cd
09	PD2	85.9	cde
10	PMD2	78.8	de
07	RD2	72.0	de
11	SMD2	65.6	de
08	SD2	61.2	e

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 48.--Lower site mean percent bare ground (X33) in September 1968 (may have overstory).

Treatment No.	Treatment Code	Percent Bare Ground	
10	PMD2	69.6	a
12	C2	67.3	a
11	SMD2	66.7	a
09	PD2	63.6	ab
06	PD1	62.9	ab
07	RD2	60.4	ab
04	SMD1	60.3	ab
02	PMD1	57.9	ab
03	C1	56.4	abc
08	SD2	55.2	abc
05	SD1	47.4	bc
01	RD1	41.5	c

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 49.--Upper site mean percent bare ground (X33) in September 1968 (may have overstory).

Treatment No.	Treatment Code	Percent Bare Ground	
08	SD2	66.0	a
07	RD2	62.0	a
11	SMD2	61.5	a
10	PMD2	51.4	a
09	PD2	51.0	a
12	C2	34.6	b
03	C1	22.6	bc
01	RD1	22.1	bc
06	PD1	19.8	bc
02	PMD1	17.9	c
04	SMD1	15.8	c
05	SD1	8.4	c

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 50.--Lower site mean percent soil organic matter content in the surface inch (X39) in September 1968.

Treatment No.	Treatment Code	Percent Organic Matter
08	SD2	2.1
05	SD1	1.4
04	SMD1	1.2
01	RD1	1.2
11	SMD2	1.2
03	C1	1.1
02	PMD1	1.1
10	PMD2	1.1
07	RD2	1.0
12	C2	0.9
09	PD2	0.9
06	PD1	0.8

Above values are not significantly different at the 5-percent probability level.

Table 51.--Upper site mean percent soil organic matter content in the surface inch (X39) in September 1968.

Treatment No.	Treatment Code	Percent Organic Matter	
01	RD1	2.1	a
02	PMD1	2.0	a
12	C2	1.7	ab
10	PMD2	1.7	ab
08	SD2	1.7	abc
04	SMD1	1.6	abc
11	SMD2	1.5	abc
09	PD2	1.4	abc
07	RD2	1.2	bc
05	SD1	1.2	bc
06	PD1	1.1	bc
03	C1	1.0	c

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 52.--Lower site mean soil bulk density (g/cc) in the surface two inches (X42) in September 1968.

Treatment No.	Treatment Code	Bulk Density
08	SD2	1.65
03	C1	1.64
05	SD1	1.63
04	SMD1	1.63
06	PD1	1.63
01	RD1	1.62
12	C2	1.62
09	PD2	1.57
02	FMD1	1.56
11	SMD2	1.56
10	PMD2	1.55
07	RD2	1.53

Above values are not significantly different at the 5-percent probability level.

Table 53.--Upper site mean soil bulk density (g/cc) in the surface two-inches (X42) in September 1968.

Treatment No.	Treatment Code	Bulk Density	
07	RD2	1.61	a
03	C1	1.53	ab
11	SMD2	1.49	abc
01	RD1	1.48	abc
05	SD1	1.48	abc
09	PD2	1.47	abc
12	C2	1.46	abc
04	SMD1	1.44	abc
06	PD1	1.42	bc
10	PMD2	1.38	bc
02	PMD1	1.33	c
08	SD2	1.33	c

Values with the same subscript are not significantly different at the 5-percent probability level.

Table 54.--Lower site mean soil bulk density (g/cc) in the surface four-inches (X43) in September 1968.

Treatment No.	Treatment Code	Bulk Density
06	PD1	1.68
08	SD2	1.67
05	SD1	1.65
03	C1	1.65
02	PMD1	1.64
12	C2	1.64
09	PD2	1.64
01	RD1	1.63
10	PMD2	1.62
04	SMD1	1.61
11	SMD2	1.59
07	RD2	1.58

Above values are not significantly different at the 5-percent probability level.

Table 55.--Upper site mean soil bulk density (g/cc) in the surface four-inches (X43) in September 1968.

Treatment No.	Treatment Code	Bulk Density	
07	RD2	1.60	a
03	C1	1.59	a
12	C2	1.57	ab
01	RD1	1.56	ab
11	SMD2	1.54	ab
05	SD1	1.53	abc
04	SMD1	1.52	abc
09	PD2	1.49	abc
08	SD2	1.45	abc
10	PMD2	1.44	bc
06	PD1	1.44	bc
02	PMD1	1.39	c

Values with the same subscript are not significantly different at the 5-percent probability level.

APPENDIX D

Tables 56 through 65

Correlation Coefficients Between Selected
1968 Dependent and Independent Variables.

and

Correlation Coefficients Between
1968 Independent Variables.

Table 56.--Correlation coefficients between selected dependent and independent variables during the 1968 lower site dry test.[a/]

Var.	I5	I10	I20	I30	INR	LOGSED
23	.119	.029	.055	.084	.109	-.230
24	.136	.050	.067	.098	.125	.236
25	-.352	-.153	-.146	-.150	-.150	.207
26	.186	.114	.034	-.005	-.002	-.008
27	.118	.080	.001	-.038	-.028	.027
28	-.013	.088	.180	.224	.243	-.123
29	.092	.171	.202	.190	.202	-.219
30	.208	.343	.469	.539	.541	-.386
31	-.082	-.190	-.334	-.342	-.323	.235
32	-.034	-.185	-.287	-.236	-.231	.226
33	-.204	-.302	-.389	-.467	-.476	.340
34	-.208	-.319	-.427	-.503	-.507	.363
35	.047	.138	.187	.208	.217	-.196
36	.219	.321	.415	.499	.508	-.355
37	-.043	-.052	-.132	-.131	-.110	.095
38	.028	-.117	-.199	-.227	-.235	.031
39	.145	.262	.290	.315	.311	.283
40	.249	.236	.222	.196	.204	-.158
41	.108	.077	.133	.138	.145	-.117
42	.099	.129	.232	.251	.237	-.111
43	.068	.023	.111	.120	.111	-.118
44	.316	.508	.647	.697	.724	-.438
45	-.237	-.423	-.597	-.638	-.665	.436
46	-.398	-.531	-.507	-.558	-.573	.247
47	-.316	-.508	-.647	-.697	-.724	.439
48	.356	.465	.557	.598	.614	-.346
49	-.375	-.468	-.551	-.575	-.591	.334
50	-.196	-.307	-.388	-.458	-.471	.273
51	-.359	-.468	-.559	-.600	-.616	.350
52	-.235	-.077	.034	.106	.117	.197
53	-.242	.032	.020	.003	.009	.323
54	-.203	.002	.042	.018	.030	.296

a/ Significance: d.f. = 46
0.05 level = .285
0.01 level = .368

Table 57.--Significant (0.05 level; *) and highly significant (0.01 level; **) relationships observed between selected dependent and independent variables during the 1968 lower site dry test.[a/]

Var.	I5	I10	I20	I30	INR	LOGSED
23						
24						
25	-*					
26						
27						
28						
29						
30		+ *	+ **	+ **	+ **	- **
31			- *	- *	- *	
32			- *			
33		- *	- **	- **	- **	+ *
34		- *	- **	- **	- **	+ *
35						
36		+ *	+ **	+ **	+ **	+ *
37						
38						
39			+ *	+ *	+ *	
40						
41						
42						
43						
44	+ *	+ **	+ **	+ **	+ **	- **
45		- **	- **	- **	- **	+ **
46	- **	- **	- **	- **	- **	
47	- *	- **	- **	- **	- **	+ **
48	+ *	+ **	+ **	+ **	+ **	- *
49	- **	- **	- **	- **	- **	+ *
50		- *	- **	- **	- **	
51	- *	- **	- **	- **	- **	+ *
52						
53						+ *
54						+ *

a/ Significance: d.f. = 46
0.05 level = 0.285
0.01 level = 0.368

Table 58.--Correlation coefficients between selected dependent and independent variables during the 1968 lower site wet test.[a/]

Var.	I5	I10	I20	I30	INR	LOGSED
23	.105	.128	.205	.229	.235	-.386
24	.136	.155	.226	.250	.257	-.399
25	-.076	-.039	-.041	-.044	-.047	.096
26	-.010	-.011	-.113	-.143	-.149	.013
27	-.030	-.026	-.127	-.158	-.164	.032
28	.211	.281	.319	.324	.327	-.334
29	.224	.216	.245	.243	.246	.284
30	.384	.494	.567	.590	.592	-.428
31	-.242	-.343	-.376	-.373	-.380	.193
32	-.294	-.322	-.286	-.269	-.263	.211
33	-.318	-.409	-.485	-.510	-.513	.400
34	-.344	-.448	-.526	-.549	-.553	.414
35	.149	.170	.200	.204	.207	-.108
36	.339	.430	.516	.544	.547	-.407
37	-.163	-.219	-.198	-.180	-.179	.026
38	-.127	-.192	-.209	-.220	-.224	.064
39	.284	.286	.302	.316	.313	-.262
40	.143	.108	.041	.029	.022	-.010
41	.164	.137	.163	.192	.199	-.148
42	.202	.249	.330	.350	.355	-.071
43	.139	.120	.162	.174	.173	-.026
44	.489	.563	.651	.681	.692	-.346
45	-.446	-.501	-.580	-.609	-.618	.306
46	-.399	-.493	-.566	-.583	-.598	.313
47	-.489	-.563	-.651	-.681	-.692	.348
48	.430	.499	.514	.520	.524	-.328
49	-.464	-.506	-.515	-.519	-.521	.316
50	-.200	-.315	-.342	-.354	-.358	.255
51	-.433	-.501	-.516	-.523	-.526	.331
52	-.076	-.019	.074	.096	.105	.174
53	.027	.041	-.001	-.030	-.032	.302
54	.046	.067	.017	-.021	-.024	.322

a/ Significance: d.f. = 46
0.05 level = 0.285
0.01 level = 0.368

Table 59.--Significant (0.05 level; *) and highly significant (0.01 level; **) relationships observed between selected dependent and independent variables during the 1968 lower site wet run.[a/]

Var.	I5	I10	I20	I30	INR	LOGSED
23						- **
24						- **
25						
26						
27						
28			+ *	+ *	+ *	- *
29						
30	+ **	+ **	+ **	+ **	+ **	- **
31		- *	- **	- **	- **	
32	- *	- *	- *			
33	- *	- **	- **	- **	- **	+ **
34	- *	- **	- **	- **	- **	+ **
35						
36	+ *	+ **	+ **	+ **	+ **	- **
37						
38						
39		+ *	+ *	+ *	+ *	
40						
41						
42			+ *	+ *	+ *	
43						
44	+ **	+ **	+ **	+ **	+ **	- *
45	- **	- **	- **	- **	- **	+ *
46	- **	- **	- **	- **	- **	+ *
47	- **	- **	- **	- **	- **	= *
48	+ **	+ **	+ **	+ **	+ **	- *
49	- **	- **	- **	- **	- **	+ *
50		- *	- *	- *	- *	
51	- **	- **	- **	- **	- **	+ *
52						
53						+ *
54						+ *

a/ Significance: d.f. = 46
0.05 level = 0.285
0.01 level = 0.368

Table 60.--Correlation coefficients between selected dependent and independent variables during the 1968 upper site dry test.[a/]

Var.	I5	I10	I20	I30	INR	LOGSED
23	.158	.237	.258	.259	.261	-.167
24	.166	.259	.287	.290	.292	-.176
25	.216	.320	.434	.453	.455	-.540
26	.331	.343	.418	.457	.462	-.389
27	.271	.369	.490	.516	.519	-.581
28	.198	.320	.467	.479	.481	-.572
29	.310	.254	.281	.310	.314	-.221
30	.422	.588	.737	.778	.783	-.698
31	-.301	-.366	-.409	-.452	-.456	.342
32	-.167	-.158	-.309	-.293	-.295	.155
33	-.412	-.597	-.735	-.784	-.789	.713
34	-.416	-.598	-.734	-.784	-.788	.708
35	.372	.531	.697	.734	.738	-.737
36	.421	.575	.724	.771	.776	-.713
37	.175	.271	.385	.403	.405	-.309
38	-.224	-.211	-.246	-.228	-.224	.046
39	.246	.392	.413	.430	.434	-.286
40	-.107	-.075	-.090	-.128	-.129	.137
41	.151	.125	.141	.150	.148	-.217
42	-.007	-.126	-.195	-.149	-.149	-.028
43	.038	.022	-.116	-.095	-.098	-.027
44	.244	.437	.449	.486	.485	-.461
45	.172	.072	-.020	-.052	-.057	.115
46	-.369	-.456	-.388	-.393	-.388	.314
47	-.244	-.433	-.446	-.483	-.482	.458
48	-.243	-.266	-.350	-.319	-.323	-.248
49	-.056	-.058	-.085	-.128	-.134	.164
50	.185	.200	.274	.277	.283	-.251
51	.236	.251	.339	.310	.314	-.246
52	.136	.158	.233	.283	.286	-.200
53	.076	-.012	-.079	-.055	-.060	.080
54	.095	-.001	-.057	-.034	-.039	.030

a/ Significance: d.f. = 46
0.05 level = 0.285
0.01 level = 0.368

Table 61.--Significant (0.05 level; *) and highly significant (0.01 level; **) relationships observed between selected dependent and independent variables during the 1968 upper site dry run.[a/]

Var.	I5	I10	I20	I30	INR	LOGSED
23						
24			+ *	+ *	+ *	
25		+ *	+ **	+ **	+ **	- **
26	+ *	+ *	+ **	+ **	+ **	- **
27		+ **	+ **	+ **	+ **	- **
28		+ *	+ **	+ **	+ *	- **
29				+ *	+ *	- **
30	+ **	+ **	+ **	+ **	+ **	
31	- *	- *	- **	- **	- **	+ *
32			- *	- *	- *	
33	- **	- **	- **	- **	- **	+ **
34	- **	- **	- **	- **	- **	+ **
35	+ **	+ **	+ **	+ **	+ **	- **
36	+ **	+ **	+ **	+ **	+ **	- **
37			+ **	+ **	+ **	- *
38						
39		+ **	+ **	+ **	+ **	- *
40						
41						
42						
43						
44		+ **	+ **	+ **	+ **	- **
45						
46	- **	- **	- **	- **	- **	+ *
47		- **	- **	- **	- **	+ **
48			- *	- *	- *	
49						
50						
51			+ *	+ *	+ *	
52					+ *	
53						
54						

a/ Significance: d.f. = 46
0.05 level = 0.285
0.01 level = 0.368

Table 62.--Correlation coefficients between selected dependent and independent variables during the 1968 upper site wet test.[a/]

Var.	I5	I10	I20	I30	INR	LOGSED
23	-.019	.058	.091	.102	.103	-.115
24	.008	.090	.108	.116	.117	-.102
25	.351	.476	.504	.497	.497	-.598
26	.363	.463	.507	.516	.520	-.466
27	.401	.539	.573	.569	.570	-.651
28	.410	.542	.560	.554	.553	-.612
29	.234	.301	.362	.374	.379	-.270
30	.504	.724	.774	.775	.776	-.699
31	-.331	-.436	-.472	-.484	-.487	.374
32	.164	-.267	-.292	-.282	-.282	.189
33	-.547	-.748	-.791	-.791	-.791	.718
34	-.548	-.748	-.791	-.792	-.793	.714
35	.518	.727	.771	.770	.771	-.752
36	.495	.717	.772	.775	.776	-.709
37	.085	.233	.312	.318	.321	-.303
38	-.217	-.204	-.168	-.146	-.145	.065
39	.392	.436	.500	.520	.524	-.403
40	.064	-.032	-.054	-.051	-.052	.026
41	-.020	.083	.071	.062	.064	-.119
42	-.162	-.077	-.060	-.062	-.061	.004
43	-.091	-.081	-.077	-.080	-.083	.043
44	.359	.456	.474	.484	.485	-.458
45	.073	-.027	-.096	-.111	-.116	.109
46	-.387	-.388	-.344	-.338	-.336	.317
47	-.355	-.452	-.472	-.481	-.483	.455
48	-.033	-.099	-.172	-.199	-.201	.208
49	-.020	-.128	-.221	-.244	-.247	.209
50	.015	.117	.221	.252	.256	-.242
51	.024	.091	.168	.195	.197	-.207
52	.075	.225	.325	.347	.351	-.258

a/ Significance: d.f. = 46
0.05 level = 0.285
0.01 level = 0.368

Table 63.--Significant (0.05 level; *) and highly significant (0.01 level; **) relationships observed between selected dependent and independent variables during the 1968 upper site wet run.[a/]

Var.	I5	I10	I20	I30	INR	LOGSED
23						
24						
25	+ *	+ **	+ **	+ **	+ **	- **
26	+ *	+ **	+ **	+ **	+ **	- **
27	+ **	+ **	+ **	+ **	+ **	- **
28	+ **	+ **	+ **	+ **	+ **	- **
29		+ *	+ *	+ **	+ **	
30	+ **	+ **	+ **	+ **	+ **	- **
31	- *	- **	- **	- **	- **	+ **
32			- *			
33	- **	- **	- **	- **	- **	+ **
34	- **	- **	- **	- **	- **	+ **
35	+ **	+ **	+ **	+ **	+ **	- **
36	+ **	+ **	+ **	+ **	+ **	- **
37			+ *	+ *	+ *	- *
38						
39	+ **	+ **	+ **	+ **	+ **	- **
40						
41						
42						
43						
44	+ *	+ **	+ **	+ **	+ **	- **
45						
46	- **	- **	- *	- *	- *	
47	- *	- **	- **	- **	- **	+ **
48						
49						
50						
51						
52			+ *	+ *	+ *	
53						
54						

a/ Significance: d.f. = 46
0.05 level = 0.285
0.01 level = 0.368

Table 64 . Correlation coefficients indicating degree of relationship between independent variables at the lower site in 1968. [a/]

Variable No.	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
23	1.000	.987	-.144	-.206	-.223	.639	-.021	.226	-.242	-.202	-.138	-.173	-.061	.139	-.074	-.222
24		1.000	-.128	-.215	-.229	.651	.006	.211	-.212	-.223	-.128	-.158	-.008	.133	-.065	-.269
25			1.000	-.059	.112	-.078	.080	.161	-.022	.048	-.173	-.168	.243	.182	-.208	.065
26				1.000	.984	-.167	-.007	-.051	.249	.170	-.020	.024	.005	.023	.154	.113
27					1.000	-.174	.009	-.026	.251	.179	-.049	-.003	.047	.053	.124	.124
28						1.000	-.012	.462	-.443	-.298	-.349	-.408	.251	.336	-.372	-.420
29							1.000	.075	.054	-.085	-.202	-.183	.331	.216	.155	.058
30								1.000	-.488	-.132	-.938	-.975	-.220	.926	-.261	-.096
31									1.000	.582	.208	.371	-.045	-.171	.617	.332
32										1.000	-.147	-.039	.009	.154	.186	.402
33											1.000	.986	-.266	-.992	.099	-.039
34												1.000	-.260	-.972	.201	.021
35													1.000	.270	-.134	.077
36														1.000	-.061	.040
37															1.000	.278
38																1.000

Table 64. (Continued)

Variable No.	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
23	-.097	-.260	.226	.195	-.012	.081	-.006	-.260	-.082	-.140	.129	.116	.138	.049	.080	.038
24	-.110	-.264	.295	.213	-.014	.123	-.036	-.320	-.124	-.119	.101	.117	.116	-.003	.064	.025
25	.028	-.102	.009	-.001	.031	.027	-.087	.146	-.027	.064	-.062	-.047	-.064	.072	.076	.037
26	-.114	.417	-.146	-.232	-.342	-.243	.239	.152	.242	.052	-.028	-.096	.052	-.343	-.081	-.052
27	-.111	.400	-.144	-.238	-.336	-.233	.218	.176	.232	.066	-.042	-.105	-.066	-.326	-.065	-.040
28	-.085	-.165	.084	.190	-.070	.260	-.175	-.393	-.261	.172	-.220	.019	-.172	.072	.133	.088
29	.113	.027	.178	.063	-.038	.194	-.181	-.151	-.195	.021	-.054	.068	-.021	.043	-.116	-.141
30	.316	.186	.101	.201	.174	.361	-.303	-.366	-.360	.389	-.351	-.363	-.391	.205	.076	.048
31	.040	.333	.048	-.085	.014	-.390	.378	.248	.389	-.217	.229	.115	.218	-.131	-.101	-.061
32	.061	.349	-.119	-.188	.086	-.308	.292	.222	.309	-.081	.092	.027	.082	.133	-.048	-.061
33	-.354	-.321	-.096	-.140	-.168	-.256	.198	.306	.256	-.337	.300	.327	.339	-.215	-.036	-.011
34	-.330	-.247	N.A[b/]	-.147	-.157	-.311	.254	.334	.310	-.358	.324	.330	.359	-.227	-.052	-.021
35	.182	-.024	.036	.028	.045	.238	-.225	-.177	-.239	.275	-.333	-.032	-.277	-.087	-.169	-.216
36	.360	.330	.129	.179	.181	.294	-.233	-.336	-.293	.365	-.325	-.351	-.366	.214	.032	.009
37	.027	.045	.213	.005	-.105	-.229	.257	.038	.227	-.280	.298	.135	.280	.123	.070	.106
38	.449	.052	-.146	.014	.368	-.195	.169	.186	.196	-.046	.005	.134	.045	-.022	-.170	-.156

Table 64. (Continued)

Variable No.	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
39	1.000	-.026	.143	.320	.478	.340	-.364	-.116	-.338	.260	-.269	-.157	-.262	.127	-.119	-.099
40		1.000	-.095	-.143	.083	-.089	.085	.070	.091	.247	-.226	-.218	-.248	-.090	-.090	-.073
41			1.000	.619	.398	.287	-.272	-.210	-.288	.008	-.054	.115	-.006	.024	-.093	-.103
42				1.000	.704	.322	-.325	-.172	-.322	.057	-.091	.053	-.055	.237	-.050	-.060
43					1.000	.179	-.225	.037	-.176	.135	-.171	.006	-.134	.149	-.175	-.203
44						1.000	-.965	-.661	-.999	.620	-.669	.275	-.619	.060	-.157	-.153
45							1.000	.440	.965	-.618	.667	.273	.617	-.061	.178	.176
46								1.000	.661	-.353	.384	.153	.353	-.031	.014	.010
47									1.000	-.619	.669	.274	.619	-.059	.155	.152
48										1.000	-.967	-.736	-.999	-.014	.039	.053
49											1.000	.538	.966	.060	-.001	-.011
50												1.000	.737	-.107	-.121	-.139
51													1.000	.015	-.038	-.052
52														1.000	.335	.325
53															1.000	.983
54																1.000

a/ d.f. = n-2 = 46
Significance: 0.05 level = 0.285
0.01 level = 0.368

b/ Not Available

Table 65. Correlation coefficients indicating degree relationship between independent variables at the upper site in 1968.[a]

Variable No.	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
23	1.000	.986	-.231	.114	-.187	-.054	-.021	.248	-.029	.006	-.270	-.261	.153	.266	.416	.083
24		1.000	-.249	.110	-.204	-.071	-.028	.267	-.034	-.005	-.289	-.280	.157	.282	.412	.086
25			1.000	.273	.978	.744	.057	.588	-.376	-.143	-.564	-.567	.732	.588	.185	-.267
26				1.000	.469	.413	.873	.607	-.508	-.259	-.623	-.633	.610	.630	.134	.020
27					1.000	.774	.243	.672	-.456	-.188	-.654	-.659	.805	.677	.199	-.241
28						1.000	.127	.548	-.334	-.107	-.561	-.561	.834	.568	.028	-.273
29							1.000	.414	-.343	-.224	-.436	-.442	.354	.443	.081	.137
30								1.000	-.656	-.433	-.966	-.972	.910	.988	.406	-.192
31									1.000	.349	.565	.611	-.556	-.603	.007	.253
32										1.000	.274	.287	-.263	-.320	-.169	-.006
33											1.000	.998	-.912	-.982	-.430	.201
34												1.000	-.913	-.983	-.412	.210
35													1.000	.927	.290	-.241
36														1.000	.414	-.174
37															1.000	-.119
38																1.000

Table 65. (Continued)

Variable No.	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
23	.157	-.222	.335	.177	.279	.323	-.071	-.230	-.325	-.120	-.171	.184	.117	.158	-.089	-.137
24	.165	-.233	.375	.209	.320	.371	-.063	-.280	-.372	-.092	-.147	.151	.088	.140	-.103	-.146
25	.176	-.070	-.012	-.134	-.284	.120	.052	-.152	-.114	-.204	.114	.068	.203	.193	-.052	-.029
26	.223	-.093	.211	-.002	-.014	.332	.047	-.339	-.330	-.237	-.005	.131	.229	.164	-.101	-.077
27	.211	-.085	.035	-.124	-.263	.183	.058	-.214	-.177	-.239	.104	.091	.237	.214	-.070	-.044
28	.180	.127	.147	-.019	-.122	.146	.229	-.332	-.145	-.068	.217	-.088	.070	.126	-.209	-.166
29	.305	-.056	.101	-.003	.038	.242	-.033	-.187	-.241	-.258	-.104	.203	.249	.166	-.055	-.057
30	.408	-.210	.213	.052	.001	.510	-.055	-.413	-.507	-.354	-.064	.258	.347	.263	-.170	-.128
31	-.302	.100	-.103	.014	.136	-.252	-.161	.369	.251	.186	-.149	-.025	-.179	-.033	.093	.021
32	-.222	.168	-.111	-.019	-.098	-.041	-.114	.140	.043	.079	-.129	.034	-.084	.284	.058	.041
33	-.418	.185	-.194	-.013	-.006	-.559	.107	.411	.556	.355	.136	-.301	-.348	-.355	.161	.125
34	-.422	.184	b/	-.012	.003	-.553	.092	.419	.551	.353	.120	-.291	-.347	-.343	.160	.121
35	.350	-.066	.210	.026	-.059	.430	.045	-.427	-.427	-.277	.030	.155	.275	.278	-.218	-.173
36	.400	-.185	.213	.051	-.006	.542	-.089	-.412	-.540	-.368	-.103	.291	.363	.329	-.184	-.146
37	.225	-.442	.156	-.037	.056	.473	-.303	-.164	-.474	-.404	-.268	.435	.399	.471	-.188	-.197
38	-.105	.244	-.076	-.007	.125	-.104	-.277	.338	.105	.058	-.476	.221	-.047	-.102	.206	.184

Table 65. (Continued)

Variable No.	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
39	1.000	.018	-.206	-.107	-.153	.407	-.237	-.158	-.407	-.289	-.138	.289	.293	.116	-.122	-.160
40		1.000	-.225	-.259	-.299	-.258	.040	.196	.258	.138	-.341	.078	-.132	.047	.146	.147
41			1.000	.662	.678	.346	.202	-.493	-.350	.287	.336	-.419	-.295	.111	-.092	-.105
42				1.000	.769	.195	.164	-.322	-.197	.437	.258	.463	-.441	-.089	.053	.041
43					1.000	.257	.173	-.387	-.262	.380	.214	-.400	-.384	-.102	-.007	-.040
44						1.000	-.367	-.581	-.999	-.067	-.047	.088	.069	.219	-.185	-.186
45							1.000	-.543	.366	.202	.560	-.475	-.211	-.093	-.068	-.051
46								1.000	.582	-.118	-.446	.336	.123	-.114	.228	.213
47									1.000	.066	.045	-.087	-.068	-.218	-.188	.188
48										1.000	.244	-.836	-.999	-.191	.358	.332
49											1.000	-.723	-.248	-.321	-.292	-.287
50												1.000	.840	.269	-.134	-.116
51													1.000	.182	-.361	-.335
52														1.000	.189	.170
53															1.000	.972
54																1.000

a/ d.f. = N-2 = 46
Significance: 0.05 level = 0.285
0.001 level = 0.368

b/ Not Available

APPENDIX E

DETAILED DESCRIPTION OF TREATMENTS

This appendix is provided for the reader who desires detailed information concerning the development of the 12 treatments shown in Table 2 of the text and duplicated here as Table 68.

Each study area was divided into 48 macroplots. Macroplots at the lower site were 100 by 50 feet. Macroplots at the upper site were 50 by 50 feet. Smaller macroplots were utilized at the upper site in an attempt to obtain some degree of homogeneity in slope, aspect, and soil type among the rolling topography.

1965 TREATMENTS:

The initial study plan provided for the seeding of two species of perennial grass (fairway crested wheatgrass, *Agropyron cristatum*; and intermediate wheatgrass, *A. intermedium*) on big sagebrush dominated sites. The treatments were distributed in a randomized block design at each site. They are summarized in Table 66 and illustrated in Figures 32 and 33. These initial (1965) treatments were applied as described in the following schedule.

Spraying was done with approximately three pounds of 2,4-D acid equivalent per acre on June 4, 1965. The percentage of sagebrush killed varied from 70-100 percent.

Plowing was done on October 19 and 20, using a 2-bottom moldboard plow. Drilling at the rate of eight pounds per acre was done with a baby rangeland drill. The contour deep furrow drilling was done with a modified baby rangeland drill (Asher, 1971, 1972). The modifications included the removal of two discs - leaving three more widely spaced discs (24-inch spacing instead of 18-inch spacing) and applying

increased disc curvature and more weight to the remaining three discs. The result is deeper, wider, and more widely spaced furrows. Ripping was done after the drilling operation. Ripping depth varied from about 8 to 15 inches. The individual rips were spaced at approximately five feet.

To eliminate grazing pressure, each area was fenced with a four-strand barbed wire fence. Chicken wire was strung along the bottom of the fence to exclude rabbits from the study area. Despite frequent fence repairs, rabbits were not excluded after 1967.

Table 66.--Treatments initiated in 1965.

No. of Replications	Trt. No.	
4	1A	Rip and drill crested wheatgrass (*Agropyron cristatum*)
4	1B	Rip and drill intermediate wheatgrass (*Agropyron intermedium*)
4	2A	Plow and contour deep furrow drill Ag cr
4	2B	Plow and contour deep furrow drill Ag in
8	3	None (Control)
4	4A	Spray herbicide and contour deep furrow drill Ag cr
4	4B	Spray herbicide and contour deep furrow drill Ag in
4	5A	Spray herbicide (2,4-D) and drill Ag cr
4	5B	Spray herbicide and drill Ag in
4	6A	Plow and drill Ag cr
4	6B	Plow and drill Ag in
48 Total		

1966 INFILTRATION TESTS:

Gifford (1968a) reported that the seedings failed because of an extremely dry spring. He therefore combined all plots of the same cultural treatment, ignoring differences in seeded species. Thus, the 1A treatments were combined with the 1B treatments. In this manner there developed six treatments (including the controls) with eight replications at each site. Gifford then selected one-half of the treated and control plots at each site for infiltration tests during August 1966 (Table 67). During this selection the randomized block design was erased. These plots (24 at each site) were sprinkled in both the dry and wet condition.

1967 TREATMENTS:

Treated plots that were not tested during the 1966 infiltration tests were reseeded in November of 1967. This was done in an attempt to compensate for the poor 1965 seeding. Plots that were tested with the infiltrometer in 1966 were left intact so comparisons could be made between the 1966 results and the results of future infiltration tests. This program provided 12 treatments with four replicates at each site.

During the fall the runoff plots were removed from each of the macroplots scheduled for retreatment. At the upper site the plots were plowed with a moldboard plow in an attempt to turn under a rather dense stand of cheatgrass. Plots at the lower site were not replowed because there had been no large invasion of the treated area by annuals of any kind.

Agropyron desertorum was the seeded species on all plots drilled in 1967. Plots that were initially drilled with a standard baby rangeland drill were redrilled with the same machine at the rate of eight pounds per acre. Plots that were initially drilled with the modified baby rangeland drill were redrilled with the same modified baby rangeland drill. The treatment summaries are described in Table 68 and illustrated in Figures 34 and 35.

EAST

48/2A	47/03	46/1B	45/6A	44/4A	43/5B			42/1A		41/5A	40/6B	39/4B	38/2B		37/03	
25/2B	26/4B	27/6B	28/03	29/2A				30/5A		31/5B	32/1B	33/4A	34/03		35/6A	36/1A
24/5B	23/03	22/6A	21/1A	20/4A			19/1B	18/5A		17/4B	16/2B	15/03		14/2A	13/6B	
01/1A	02/4A	03/2B		04/5A			05/2A	06/4B		07/03	08/6B	09/5B	10/03		11/6A	12/1B

WEST

Figure 32.--General plot design at lower site after 1965 treatments. Each macro-plot is 50 X 100 feet. Plot numbers are shown in the numerator and treatment codes as described in Table 66 are shown in the denominator.

EAST

48/5A	47/5B	46/2A		45/03	44/6A	43/1B
37/03	38/6B	39/1A	40/4A	41/2B	42/4B	
36/2B	35/6B	34/03		33/4A	32/5B	31/1A
25/5A	26/03	27/1B	28/4B	29/2A	30/6A	
24/2A	23/4B	22/2B	21/1B	20/03	19/5B	
13/1A	14/03	15/4A	16/5A	17/6B	18/6A	
12/1B	11/6A	10/5A	09/4B	08/2A	07/03	
01/5B	02/4A	03/03	04/2B	05/1A	06/6B	

WEST

Figure 33.--General plot design at upper site after 1965 treatments. Each macro-plot is 50 X 50 feet. Plot numbers are shown in the numerator and treatment codes as described in Table 66 are shown in the denominator.

Table 67.--Plots and corresponding treatments selected for infiltration tests in August 1966.

Treatment No.	Plot Numbers Lower Site	Upper Site
1A	01	31
1A	42	39
1B	32	12
1B	46	21
2A	05	08
2A	29	46
2B	16	04
2B	25	36
3	07	03
3	10	20
3	23	26
3	47	34
4A	02	15
4A	44	33
4B	17	09
4B	26	42
5A	04	10
5A	18	48
5B	31	01
5B	43	32
6A	22	18
6A	45	30
6B	08	06
6B	27	38

Treatments: 1 = rip and drill; 2 = plow, modify drill; 3 = control; 4 = spray, modify drill; 5 = spray, drill; 6 = plow, drill.

EAST

48/10	47/03	46/01	45/06	44/04	43/05			42/01		41/08	40/09	39/11	38/10		37/12	
25/02	26/04	27/06	28/12	29/02				30/08		31/05	32/01	33/11	34/12		35/09	36/07
24/08	23/03	22/06	21/07	20/11			19/07	18/05		17/04	16/02	15/12		14/10	13/09	
01/01	02/04	03/10		04/05			05/02	06/11		07/03	08/06	09/08	10/03		11/09	12/07

WEST

Figure 34.--General plot design at lower site after 1967 treatments. Each macro-plot is 50 X 100 feet. Plot numbers are shown in the numerator and treatment codes as described in Table 68 are shown in the denominator.

EAST

$\frac{48}{05}$	$\frac{47}{08}$	$\frac{46}{02}$		$\frac{45}{12}$	$\frac{44}{09}$	$\frac{43}{07}$
$\frac{37}{12}$	$\frac{38}{06}$	$\frac{39}{01}$	$\frac{40}{11}$	$\frac{41}{10}$	$\frac{42}{04}$	
$\frac{36}{02}$	$\frac{35}{09}$	$\frac{34}{03}$		$\frac{33}{04}$	$\frac{32}{05}$	$\frac{31}{01}$
$\frac{25}{08}$	$\frac{26}{03}$	$\frac{27}{07}$	$\frac{28}{11}$	$\frac{29}{10}$	$\frac{30}{06}$	
$\frac{24}{10}$	$\frac{23}{11}$	$\frac{22}{10}$	$\frac{21}{01}$	$\frac{20}{03}$	$\frac{19}{08}$	
$\frac{13}{07}$	$\frac{14}{12}$	$\frac{15}{04}$	$\frac{16}{08}$	$\frac{17}{09}$	$\frac{18}{06}$	
$\frac{12}{01}$	$\frac{11}{09}$	$\frac{10}{05}$	$\frac{09}{04}$	$\frac{08}{02}$	$\frac{07}{12}$	
$\frac{01}{05}$	$\frac{02}{11}$	$\frac{03}{03}$	$\frac{04}{02}$	$\frac{05}{07}$	$\frac{06}{06}$	

WEST

Figure 35.--General plot design at upper site after 1967 treatments. Each macro-plot is 50 X 50 feet. Plot numbers are shown in the numerator and treatment codes as described in Table 68 are shown in the denominator.

Table 68.--Treatments resulting from the combined cultural practices of 1965 and 1967 (four replicates in each treatment).

No.	Code[a/]	Treatment Description
1.	RD1	Rip and drill in 1965. Test with infiltrometer in 1966.
2.	PMD1	Plow, contour deep furrow drill in 1965. Test with infiltrometer in 1966.
3.	C1	Control. Test with infiltrometer in 1966.
4.	SMD1	Spray herbicide, contour deep furrow drill in 1965. Test with infiltrometer in 1966.
5.	SD1	Spray herbicide, and drill in 1965. Test with infiltrometer in 1966.
6.	PD1	Plow and drill 1965. Test with infiltrometer in 1966.
7.	RD2	Rip and drill in 1965. Drill in 1967.
8.	SD2	Spray and drill in 1965. Drill in 1967.
9.	PD2	Plow and drill 1965. Drill in 1967.
10.	PMD2	Plow and contour deep furrow drill in 1965. Contour deep furrow drill in 1967.
11.	SMD2	Spray herbicide and contour deep furrow drill in 1965. Contour deep furrow drill in 1967.
12.	C2	Control. Not tested with infiltrometer in 1966.

a/ In future tables and figures a mnemonic code is used to help the reader recall the above treatment descriptions. The codes are as follows: R = rip; D = drill with standard baby rangeland drill; P = plow; MD = drill with modified baby rangeland drill; S = spray; C = control; the number 1 implies plots established in 1965 and tested with the infiltrometer in 1966; the number 2 implies plots established in 1965, not tested with the infiltrometer in 1966, and retreated in 1967.